Strength of Materials Important Questions PDF

The most important Strength of Materials topics are simple stress and strain with elastic constants, compound stresses and Mohr's circle, shear force and bending moment diagrams, bending and shear stresses in beams, deflection, torsion of shafts, Euler's column theory and thin cylinders. Practise SFD and BMD until you can draw them quickly, and learn the standard derivations for bending and torsion.

Key takeaways

- These are practice questions based on common B.Tech syllabus topics. They are not verified past papers.
- Check your own university syllabus and official question papers before revising.
- SFD and BMD questions appear in some form in almost every SOM syllabus. Practise them daily.
- Learn the bending equation $M/I = \sigma/y = E/R$ and the torsion equation $T/J = \tau/r = G\theta/L$ with their assumptions.
- Keep units in N and mm throughout. Then stress comes out directly in MPa.

Before you start: about these questions

This subject is called Strength of Materials, Mechanics of Solids or Mechanics of Materials depending on the university. The five units below follow the usual Indian B.Tech pattern. These are **practice questions based on common syllabus topics, not verified past papers**. Compare them with your own syllabus and official papers. AKTU students can use the official AKTU old question paper page. The Uncodemy previous year question papers hub links official sources for other universities.

The scientific calculator handles powers and roots for shaft and column numericals, and the unit converter helps with kN, MPa and GPa.

Unit 1: Simple stresses, strains and elastic constants

Definitions and short questions

- Define stress, strain, Hooke's law and modulus of elasticity.
- Draw and explain the stress-strain curve for mild steel. Mark proportional limit, yield point and ultimate stress.
- Define Poisson's ratio, bulk modulus and modulus of rigidity.
- What is thermal stress? Why does it occur only when expansion is restrained?

- Define strain energy, resilience and proof resilience.

Derivations

- Derive the relation $E = 2G(1 + \mu)$ and $E = 3K(1 - 2\mu)$.
- Derive the elongation of a bar due to its own weight: $\delta = \rho g L^2/2E$.
- Derive stresses due to gradually applied, suddenly applied and impact loads.

Numerical

- A steel rod 20 mm in diameter and 2 m long carries an axial load of 50 kN. E = 200 GPa. Find stress and elongation. *Outline:* $A = \pi/4 \times 20^2 \approx 314.2$ mm². $\sigma = 50{,}000/314.2 \approx$ **159.2 MPa**. $\delta = PL/AE = 50{,}000 \times 2000/(314.2 \times 200{,}000) \approx$ **1.59 mm**.

Unit 2: Compound stresses and Mohr's circle

Definitions and short questions

- Define principal planes and principal stresses.
- What is the maximum shear stress plane and how is it inclined to the principal planes?
- State the uses of Mohr's circle.

Derivations

- Derive normal and shear stress on an oblique plane for a body under two perpendicular normal stresses and shear stress.
- Derive the expression for principal stresses: $\sigma_{1,2} = (\sigma_x + \sigma_y)/2 \pm \sqrt{[((\sigma_x - \sigma_y)/2)^2 + \tau^2]}$.

Numerical

- At a point, $\sigma_x = 80$ MPa, $\sigma_y = 20$ MPa (both tensile) and $\tau_{xy} = 30$ MPa. Find principal stresses and maximum shear stress. *Outline:* centre = 50 MPa, radius = $\sqrt{(30^2 + 30^2)} \approx 42.43$ MPa. $\sigma_1 \approx$ **92.4 MPa**, $\sigma_2 \approx$ **7.6 MPa**, $\tau_{max} \approx$ **42.4 MPa**. Principal plane angle from $\tan 2\theta = 2\tau/(\sigma_x - \sigma_y) = 1$, so $\theta =$ **22.5°**. Confirm with Mohr's circle.

Unit 3: Shear force, bending moment and bending stresses

Definitions and short questions

- Define shear force and bending moment. What sign convention do you follow?
- What is the point of contraflexure?
- State the relation between load, shear force and bending moment.
- State the assumptions of the theory of simple bending.
- Define section modulus. Why is an I-section preferred for beams?

Derivations

- Derive the bending equation $M/I = \sigma/y = E/R$.
- Derive the shear stress distribution in a beam, $\tau = FA\bar{y}/(Ib)$, and show that maximum shear stress in a rectangular section is 1.5 times the average.

Numericals

- Draw SFD and BMD for a simply supported beam of 6 m span carrying a UDL of 10 kN/m over the full span. *Outline:* reactions = $wL/2$ = **30 kN** each. Maximum BM at mid-span = $wL^2/8$ = **45 kN·m**. SF varies linearly from +30 to -30 kN.
- The same beam has a rectangular section 100 mm wide and 200 mm deep. Find maximum bending stress. *Outline:* $Z = bd^2/6 = 100 \times 200^2/6 \approx 666{,}667$ mm³. $\sigma = M/Z = 45 \times 10^6/666{,}667$ = **67.5 MPa**.
- Draw SFD and BMD for an overhanging beam with point loads and a UDL, and locate the point of contraflexure. *Outline:* find reactions by moment equilibrium, compute SF and BM at each key point, and set the BM expression to zero in the overhang region.

Unit 4: Deflection of beams

Definitions and short questions

- Define slope and deflection. State the differential equation of the elastic curve, $EI\,d^2y/dx^2 = M$.
- What is flexural rigidity?
- Compare double integration, Macaulay's method and the moment area method.

Derivations

- Derive the maximum deflection of a simply supported beam with central point load: $\delta = WL^3/48EI$.
- Derive the maximum deflection of a simply supported beam with UDL: $\delta = 5wL^4/384EI$.
- Derive slope and deflection at the free end of a cantilever with point load: $\theta = WL^2/2EI$, $\delta = WL^3/3EI$.

Numerical

- Use Macaulay's method to find deflection under the loads for a simply supported beam with two unequal point loads. *Outline:* write a single BM expression with Macaulay brackets, integrate twice, apply $y = 0$ at both supports and solve for constants.

Unit 5: Torsion, columns and thin cylinders

Definitions and short questions

- State the assumptions of the torsion theory.
- Define polar moment of inertia and torsional rigidity.
- Why is a hollow shaft stronger than a solid shaft of the same weight?
- State Euler's formula and its limitations. Define slenderness ratio and effective length.
- Define hoop stress and longitudinal stress in a thin cylinder.

Derivations

- Derive the torsion equation $T/J = \tau/r = G\theta/L$.
- Derive Euler's crippling load for a column with both ends hinged: $P = \pi^2EI/L^2$.
- Derive hoop stress $pd/2t$ and longitudinal stress $pd/4t$ for a thin cylinder.

Numericals

- A solid shaft transmits 100 kW at 300 rpm. Allowable shear stress is 60 MPa. Find the diameter. *Outline:* $T = P/\omega = 100{,}000/(2\pi \times 300/60) \approx 3183$ N·m. $d^3 = 16T/(\pi\tau) = 16 \times 3.183 \times 10^6/(\pi \times 60) \approx 270{,}200$ mm³, so d ≈ **64.6 mm**; adopt **65 mm**.
- A column 3 m long, hinged at both ends, has a solid circular section of 50 mm diameter. E = 200 GPa. Find Euler's load. *Outline:* $I = \pi d^4/64 \approx 306{,}800$ mm⁴. $P = \pi^2 EI/L^2 = 9.87 \times 200{,}000 \times 306{,}800/3000^2 \approx$ **67.3 kN**.
- A thin cylinder of 1 m diameter and 10 mm wall thickness has internal pressure 2 MPa. Find hoop and longitudinal stress. *Outline:* $\sigma h = pd/2t = 2 \times 1000/20 =$ **100 MPa**. $\sigma l = pd/4t =$ **50 MPa**.

How to score well in Strength of Materials

- **Free body diagram first.** Show supports, loads and reactions with directions.
- **Check equilibrium.** Sum of vertical forces must be zero. A quick check saves a whole wrong SFD.
- **Label diagrams fully.** Write values at every key point on SFD and BMD, including the maximum and contraflexure points.
- **Use N and mm.** Stress then comes out in N/mm², which equals MPa.
- **Write assumptions in derivations.** Each assumption is often worth a mark.
- **Practise one SFD/BMD and one shaft numerical daily** in the month before the exam.

Frequently asked questions

Are these Strength of Materials questions from past papers?

No. They are practice questions based on common B.Tech syllabus topics. Check your university syllabus and official question papers, such as the AKTU old question paper page.

Which topic is most important in Strength of Materials?

SFD and BMD, bending stress, torsion and principal stresses appear in most syllabi and connect to later subjects such as machine design and structural analysis.

How do I get faster at SFD and BMD?

Find reactions first, then work section by section from one end. Remember that the slope of the BMD equals the shear force, and BM is maximum where SF changes sign.

Are Mechanics of Solids and Strength of Materials the same?

They cover largely the same topics. Universities use different names and may move deflection, columns or cylinders between papers, so check your syllabus.

Which derivations are asked most in SOM?

Common ones are the bending equation, the torsion equation, principal stresses, Euler's load for a hinged column, beam deflection formulas and thin cylinder stresses.

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Sources and further reading

- AKTU old question papers (official)
- NPTEL courses
- AICTE (model curriculum and approvals)

About this PDF

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