Structural Analysis Important Questions PDF

Structural Analysis papers usually test determinacy and stability, deflection methods, indeterminate beams and frames (slope deflection and moment distribution), influence lines with arches and cables, and an introduction to matrix and plastic analysis. Most marks come from numericals, so practise standard cases until the steps are automatic. Use these practice questions alongside your own university syllabus and official papers.

Key takeaways

- These are practice questions based on common syllabus topics. They are not verified past papers.
- Learn standard results by heart: deflections, fixed end moments, prop reactions and collapse loads.
- Moment distribution and slope deflection questions are long. Practise a full two-span and a portal frame problem.
- Always draw the bending moment diagram at the end. Many papers give marks for it separately.
- Check every answer with equilibrium: reactions must balance the applied load.

Before you start: how to use these questions

These questions follow the topics in a standard Indian B.Tech Civil Structural Analysis syllabus. They are practice questions, not copies of any exam paper. Compare them with your own university syllabus and official question papers. AKTU students can use the AKTU old question paper archive, and Uncodemy lists more previous year question paper sources. A scientific calculator helps you check long arithmetic.

Unit 1: Determinacy, stability and trusses

Definitions (2 to 3 marks)

- Define static indeterminacy and kinematic indeterminacy.
- What is the difference between internal and external indeterminacy?
- When is a structure geometrically unstable even if it has enough reactions?
- Differentiate a perfect, deficient and redundant truss.

Derivations and theory

- Write the formulas for degree of static indeterminacy: plane truss $D_s = m + r - 2j$; plane rigid frame $D_s = 3m + r - 3j$.
- Explain the method of joints and the method of sections for trusses.

Numericals

1. Find the static indeterminacy of a propped cantilever. *Outline:* fixed support gives 3 reactions and the prop gives 1, so $r = 4$; $D_s = 4 - 3 = 1$.
2. Find the forces in all members of a simple Pratt or Warren truss under given panel loads. *Outline:* find reactions first, then use joints with only two unknowns, and use a section for members in the middle.

Unit 2: Deflection of beams and frames

Definitions

- Define slope and deflection. State the sign convention you use.
- State the two moment area theorems.
- What is a conjugate beam? Give the support changes from real to conjugate beam.
- State Castigliano's first and second theorems.

Derivations

- Derive the differential equation of the elastic curve: $EI\,d^2y/dx^2 = M$.
- Derive the maximum deflection of a simply supported beam with UDL: $5wL^4/384EI$.
- Derive the deflection at the free end of a cantilever with an end point load: $WL^3/3EI$.
- Derive the central deflection of a simply supported beam with a central point load: $WL^3/48EI$.

Numericals

1. A simply supported beam of span 6 m carries a UDL of 20 kN/m. $EI = 2 \times 10^4$ kN·m². Find the maximum deflection. *Outline:* $\delta = 5 \times 20 \times 6^4 / (384 \times 2 \times 10^4) = 0.0169$ m, about 16.9 mm.
2. Use Macaulay's method to find the deflection under a point load placed off-centre on a simply supported beam. *Outline:* write one moment equation with brackets, integrate twice, apply $y = 0$ at both supports.
3. Find the horizontal deflection of a roller support of a portal frame using unit load method. *Outline:* $\delta = \int Mm\,dx / EI$ over each member.

Unit 3: Indeterminate beams and frames

Definitions

- Define fixed end moments, carry-over factor, stiffness factor and distribution factor.
- State the three-moment theorem (Clapeyron's theorem).
- What is sway in a portal frame and when does it occur?

Standard results to remember

- Fixed end moment, UDL: $wL^2/12$ at each end.
- Fixed end moment, central point load: $WL/8$ at each end.

- Propped cantilever with UDL: prop reaction 3wL/8, fixed end moment $wL^2/8$.
- Carry-over factor for a prismatic member with far end fixed: 1/2.

Numericals

1. A two-span continuous beam has equal spans of 5 m and a UDL of 12 kN/m on both spans. Find the support moment at the middle support. *Outline:* by the three-moment theorem with simple end supports, $M_B = wL^2/8 = 12 \times 25/8 = 37.5$ kN·m (hogging).
2. Analyse a continuous beam of three spans by moment distribution. *Outline:* compute stiffness and distribution factors, fixed end moments, then balance and carry over until changes are small. Find reactions span by span and draw the BMD.
3. Analyse a single-bay portal frame with sway using slope deflection. *Outline:* write slope deflection equations for each member, joint equilibrium equations and one shear (sway) equation, then solve for rotations and sway.

Unit 4: Influence lines, arches and cables

Definitions

- What is an influence line? How is it different from a bending moment diagram?
- State the Müller-Breslau principle.
- Define a three-hinged and a two-hinged arch. Define linear arch.

Derivations and theory

- Draw influence lines for reactions, shear and bending moment at a section of a simply supported beam.
- Show that a three-hinged parabolic arch carrying a UDL over the whole span has zero bending moment everywhere.
- Derive the horizontal thrust in a cable under UDL: $H = wL^2/8d$.

Numericals

1. A three-hinged parabolic arch has a span of 20 m and a rise of 4 m. It carries a UDL of 10 kN/m over the whole span. Find the reactions. *Outline:* $V = wL/2 = 100$ kN at each support; $H = wL^2/8h = 10 \times 400 / 32 = 125$ kN.
2. A train of wheel loads crosses a simply supported girder. Find the maximum bending moment. *Outline:* the maximum moment under a load occurs when that load and the resultant are equidistant from mid-span; check the nearby loads too.
3. Find the maximum positive and negative shear at a section when a UDL longer than the span rolls across.

Unit 5: Matrix methods and plastic analysis

Definitions

- Define flexibility and stiffness coefficients.
- Compare the flexibility (force) method and the stiffness (displacement) method.
- Define plastic hinge, plastic moment, shape factor and collapse mechanism.

- State the static (lower bound) and kinematic (upper bound) theorems.

Derivations

- Derive the shape factor of a rectangular section: $Zp/Ze = (bd^2/4)/(bd^2/6) = 1.5$.
- Find the shape factor of a circular section: about 1.7.

Numericals

1. Find the collapse load of a simply supported beam with a central point load. *Outline:* Wc = 4Mp/L.
2. Find the collapse load of a fixed beam with a central point load. *Outline:* three hinges form; Wc = 8Mp/L.
3. Find the collapse load of a propped cantilever with a central point load. *Outline:* hinges at the fixed end and under the load; Wc = 6Mp/L.
4. Form the stiffness matrix of a two-span continuous beam and solve for joint rotations.

How to score well in Structural Analysis

- **Write the method name first.** "By moment distribution method" tells the examiner what to look for.
- **Tabulate.** Moment distribution and stiffness work need neat tables. A clean table earns step marks even with a small slip.
- **Check equilibrium.** Sum of vertical reactions must equal the total load.
- **Draw SFD and BMD with values.** Mark maximum values and points of contraflexure.
- **Memorise standard results.** They save time and let you check long answers.
- **Practise official papers.** Solve at least three past papers from your own university in timed conditions.

Frequently asked questions

Are these Structural Analysis questions from past papers?

No. They are practice questions based on topics common to most B.Tech Civil syllabi. Check your own university syllabus and official papers before the exam.

Which method is most important in Structural Analysis?

Moment distribution and slope deflection appear in most papers, along with deflection methods and influence lines. Practise at least one full problem of each type.

How do I avoid mistakes in moment distribution?

Keep one sign convention, check that distribution factors at each joint add up to 1, and stop when the balancing moments become very small. Then check equilibrium.

Is plastic analysis part of Structural Analysis or steel design?

It depends on the university. Many cover collapse loads in Structural Analysis and use plastic section properties again in steel design.

Where can I find official AKTU Structural Analysis papers?

AKTU publishes old question papers at aktu.ac.in/old-question-paper.html. Other universities have their own archives.

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Sources and further reading

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