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# Engineering Mechanics Important Questions PDF

Engineering Mechanics usually covers force systems and equilibrium, friction, centroid and moment of inertia, trusses and beams, and kinematics and kinetics of particles. Most questions are numericals: resultant of forces, Lami's theorem, ladder and wedge friction, belt friction, MOI of composite sections, SFD and BMD, projectiles and work-energy problems.

## Key takeaways

- Statics: resultant, Varignon's theorem, Lami's theorem, free body diagrams and equations of equilibrium.
- Friction: laws of friction, angle of repose, ladder, wedge and belt friction (T1/T2 = e^(μθ)).
- Centroid and MOI: composite areas, parallel and perpendicular axis theorems.
- Trusses, beams (SFD and BMD) and dynamics: projectiles, work-energy, impulse-momentum and collisions.
- These are practice questions based on common syllabus topics, not verified past papers.

## About these important questions

These are **practice questions** built from topics that appear in most Indian B.Tech syllabi for Engineering Mechanics, including AKTU and universities that follow the AICTE model curriculum. They are **not verified past papers**, and we do not claim that any question will appear in your exam. Unit numbers and topic order differ between universities, so first match each unit below with your own university syllabus. For real previous papers, use your university's official archive. AKTU students can download them from the AKTU old question paper page.

Each unit lists key definitions, derivations or theory questions, numericals with short answer outlines, and long-answer questions. Use the outlines to check your method, then write full solutions yourself.

## Unit 1: Force Systems and Equilibrium

**Key definitions:** force, scalar and vector quantities, coplanar concurrent and non-concurrent forces, resultant, moment, couple, Varignon's theorem, free body diagram, equilibrium, Lami's theorem.

**Numericals (answer outline):**

- Two forces of 30 N and 40 N act at a point at 90° to each other. Find the resultant. Answer: $R = \sqrt{(30^2 + 40^2)} = 50$ N at $\tan^{-1}(40/30) \approx 53.1°$ from the 30 N force.
- Find the resultant of four coplanar concurrent forces by resolving into horizontal and vertical components: $R = \sqrt{(\Sigma Fx^2 + \Sigma Fy^2)}$, angle = $\tan^{-1}(\Sigma Fy/\Sigma Fx)$.
- A lamp hangs from two strings making given angles. Find the tensions using Lami's theorem: each force is proportional to the sine of the angle between the other two.
- Find the support reactions of a body or a sphere resting between two smooth inclined planes.

**Long-answer questions:** State and prove Varignon's theorem. State the conditions of equilibrium for coplanar forces and explain the free body diagram with examples.

## Unit 2: Friction

**Key definitions:** static and kinetic friction, limiting friction, coefficient of friction, angle of friction, angle of repose, cone of friction, laws of dry friction, wedge, belt friction.

**Derivations:** derive the ratio of belt tensions for a flat belt: T1/T2 = e^(μθ).

**Numericals (answer outline):**

- A block on an inclined plane: find the force needed to move it up or down the plane, using normal reaction $R = W \cos \alpha$ and friction $F = \mu R$.
- Ladder problem: a ladder rests against a rough wall and rough floor. Find the limiting angle. Outline: draw the free body diagram, apply $\Sigma Fx = 0$, $\Sigma Fy = 0$ and moments about the base.
- With $\mu = 0.3$ and angle of lap $\theta = \pi$ radians, T1/T2 = e^(0.3π) ≈ 2.57.
- Find the force needed to lift a load using a wedge, considering friction on all contact faces.

## Unit 3: Centroid and Moment of Inertia

**Key definitions:** centre of gravity, centroid, axis of symmetry, moment of inertia (second moment of area), radius of gyration, parallel axis theorem, perpendicular axis theorem.

**Results to remember:** rectangle about its centroidal axis $bd^3/12$; triangle about its base $bh^3/12$ and about its centroidal axis $bh^3/36$; circle $\pi d^4/64$; centroid of a semicircle $4r/(3\pi)$ from the diameter; centroid of a triangle $h/3$ from the base.

**Numericals (answer outline):**

- Find the centroid of a T-section or L-section. Outline: split into rectangles, take $\bar{x} = \Sigma Ax/\Sigma A$ and $\bar{y} = \Sigma Ay/\Sigma A$.
- Find the MOI of an I-section about its centroidal axes using the parallel axis theorem: $I = Ic + Ah^2$.
- Find the centroid of an area with a circular hole by treating the hole as a negative area.

**Long-answer questions:** Derive the MOI of a rectangle and a triangle about their centroidal axes. State and prove the parallel axis theorem.

## Unit 4: Trusses and Beams

**Key definitions:** perfect, deficient and redundant trusses (perfect truss: m = 2j - 3), method of joints, method of sections, types of beams, types of supports and loads, shear force, bending

moment, point of contraflexure.

**Numericals (answer outline):**

- Analyse a simple truss by the method of joints and state whether each member is in tension or compression.
- Find the force in three members of a truss using the method of sections.
- Simply supported beam of span L with a central point load W: reactions W/2 each and maximum BM = WL/4 at the centre.
- Simply supported beam with a UDL w over span L: maximum BM = $wL^2/8$ at the centre.
- Draw the SFD and BMD for a cantilever with a point load at the free end (maximum BM = WL at the fixed end) and for an overhanging beam.

## Unit 5: Kinematics and Kinetics of Particles

**Key definitions:** displacement, velocity, acceleration, equations of motion, relative velocity, projectile, Newton's laws, D'Alembert's principle, work, energy, power, impulse, momentum, coefficient of restitution.

**Numericals (answer outline):**

- A projectile is fired at 20 m/s at 45°. Find the horizontal range. Answer: $R = u^2 \sin 2\theta / g = 400/9.81 \approx 40.8$ m. The maximum height is $u^2 \sin^2\theta / (2g) \approx 10.2$ m.
- Two blocks connected by a string over a pulley: find the acceleration and the tension, using Newton's second law or D'Alembert's principle.
- Use the work-energy principle to find the velocity of a body sliding down a rough inclined plane.
- Two balls collide directly. Find their velocities after impact given the coefficient of restitution e: $v2 - v1 = e(u1 - u2)$ together with conservation of momentum.

**Long-answer questions:** Derive the equation of the path of a projectile and show that it is a parabola. Explain D'Alembert's principle with an example.

## How to score well in Engineering Mechanics

- Start every numerical with a neat free body diagram. Many marks are given for it.
- State the sign convention and the equations you are using ($\Sigma Fx = 0$, $\Sigma Fy = 0$, $\Sigma M = 0$).
- Keep units consistent: N, kN, m, mm. Convert before you substitute.
- For SFD and BMD, calculate values at every load point and draw the diagrams to a rough scale below the beam.

## Short-answer (2-mark) questions for Engineering Mechanics

Short questions test definitions and one-line results. Practise answering each in two to four lines:

1. State the parallelogram law of forces.
2. State Lami's theorem.
3. What is a couple?
4. Define the angle of repose.

5. What is the cone of friction?
6. State the perpendicular axis theorem.
7. Define radius of gyration.
8. What is the condition for a perfect truss? (Answer: m = 2j - 3.)
9. What is a point of contraflexure?
10. State D'Alembert's principle.
11. Define the coefficient of restitution.
12. At what angle is the range of a projectile maximum? (Answer: 45°, on level ground.)

## A 7-day revision plan for Engineering Mechanics

Use this plan in the last week before the exam. Adjust it to the units and weightage in your own syllabus.

- **Day 1 (Unit 1, Force Systems and Equilibrium):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 2 (Unit 2, Friction):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 3 (Unit 3, Centroid and Moment of Inertia):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 4 (Unit 4, Trusses and Beams):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 5 (Unit 5, Kinematics and Kinetics of Particles):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 6:** attempt one full three-hour practice paper made from these questions, or an official previous paper from your university archive.
- **Day 7:** go through your formula sheet, the short-answer list and every question you got wrong in the practice paper.

## Frequently asked questions

### Which units of Engineering Mechanics are most numerical?

Every unit is mostly numerical. Friction, centroid and moment of inertia, and SFD-BMD questions are the most common long numericals, so practise many of each type.

### How do I avoid mistakes in friction problems?

Draw the free body diagram, show the friction force opposite to the direction of possible motion, resolve forces along and perpendicular to the surface, and write F = μR only at limiting equilibrium.

### Do I need to remember MOI formulas?

Yes. Learn the MOI of a rectangle, triangle, circle and semicircle, plus the parallel and perpendicular axis theorems. Composite section questions build on these.

### Are these questions from real past papers?

No. These are practice questions based on topics that are common in B.Tech syllabi. They are not verified past papers, and no question is promised to appear in your exam. Check your own university syllabus and official previous papers; AKTU students can use the AKTU old question paper archive.

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## Sources and further reading

- AKTU: Old question papers (official archive)
- AKTU: Syllabus
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## About this PDF

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