Theory of Machines Important Questions PDF

The most important Theory of Machines topics are kinematic pairs and degrees of freedom, inversions of four-bar and slider-crank chains, velocity and acceleration analysis, cam profiles, gear terminology and gear trains, belt tension ratio, flywheels and governors. Practise the graphical methods with neat drawings and learn the standard formulas with their meaning.

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.
- Graphical questions (velocity diagrams, cam profiles) need a scale, a ruler and practice. Do at least five of each.
- Gear trains and belt drives are formula-based and are among the easiest marks if you practise.
- Some universities split this subject into Kinematics of Machines and Dynamics of Machines. Check which topics are in your paper.

Before you start: about these questions

The five units below follow the common Indian B.Tech pattern for Theory of Machines. Your university may call it Kinematics of Machines or split it into two papers. These are **practice questions based on common syllabus topics, not verified past papers**. Always check your own syllabus and official papers. AKTU students can use the official AKTU old question paper page, and the Uncodemy previous year question papers hub links official sources for other universities.

The scientific calculator is handy for exponential belt calculations and radians, and the unit converter for rpm, rad/s and power units.

Unit 1: Mechanisms and machines

Definitions and short questions

- Define link, kinematic pair, kinematic chain, mechanism and machine.
- Classify kinematic pairs by type of contact and type of relative motion. Give examples of lower and higher pairs.
- What is a structure? How is it different from a mechanism?
- State Grashof's law for a four-bar chain.

Long questions

- Explain the inversions of the four-bar chain, single slider-crank chain and double slider-crank chain with one practical example each (beam engine, Whitworth quick return, elliptical trammel).
- Derive Grubler's criterion for planar mechanisms: $F = 3(n - 1) - 2j - h$.

Numerical

- Find the degrees of freedom of a four-bar mechanism. *Outline:* $n = 4$, $j = 4$ lower pairs, $h = 0$. $F = 3(4 - 1) - 2 \times 4 =$ **1**, so it is a constrained mechanism.

Unit 2: Velocity and acceleration analysis

Definitions and short questions

- What is the instantaneous centre of rotation? State the Arnold-Kennedy theorem of three centres.
- How many instantaneous centres does a mechanism with n links have?
- What is Coriolis acceleration and when does it occur?

Long questions

- Draw velocity and acceleration diagrams for a slider-crank mechanism for a given crank angle, crank speed and link lengths.
- Derive the expression for the Coriolis component of acceleration, $2v\omega$.
- Derive the approximate expressions for piston velocity and acceleration in a slider-crank mechanism.

Numerical

- Find the number of instantaneous centres in a six-link mechanism. *Outline:* $N = n(n - 1)/2 = 6 \times 5/2 =$ **15**.
- For a slider-crank with given crank length, connecting rod length and crank speed, find slider velocity at 45° crank angle. *Outline:* draw the configuration to scale, draw the velocity of the crank pin perpendicular to the crank, then close the triangle with the connecting rod velocity. Check with $v \approx \omega r\,(\sin\theta + \sin 2\theta/2n)$.

Unit 3: Cams and followers

Definitions and short questions

- Classify cams and followers.
- Define base circle, pitch curve, pressure angle, lift, dwell.
- Why is a roller follower preferred over a knife-edge follower?
- Compare uniform velocity, simple harmonic motion and uniform acceleration and retardation follower motions.

Long questions

- Draw the displacement, velocity and acceleration diagrams for a follower moving with simple harmonic motion.
- Draw the profile of a cam for a roller follower with given lift, base circle, rise, dwell and return angles.

Numerical

- Find the maximum velocity and acceleration of a follower moving with SHM, lift h, cam speed ω and outstroke angle θo. *Outline:* $v_{max} = \pi h\omega/(2\theta o)$, $a_{max} = \pi^2 h\omega^2/(2\theta o^2)$, with θo in radians.

Unit 4: Gears and gear trains

Definitions and short questions

- Define pitch circle, module, circular pitch, addendum, dedendum and pressure angle.
- State the law of gearing.
- Compare involute and cycloidal tooth profiles.
- What is interference and how can it be avoided?
- Classify gear trains: simple, compound, reverted and epicyclic.

Long questions

- Derive the expression for the length of path of contact and arc of contact for two involute gears.
- Derive the minimum number of teeth on a pinion to avoid interference.
- Explain the tabular method for finding speeds in an epicyclic gear train.

Numericals

- A driver gear with 20 teeth runs at 1200 rpm and drives a gear with 60 teeth. Find the speed of the driven gear. *Outline:* $N2 = N1 \times T1/T2 = 1200 \times 20/60 =$ **400 rpm**.
- In an epicyclic train the arm is fixed or rotates at a given speed. Find the speed of the sun or annulus. *Outline:* build the table: give the arm 0 rotation, rotate one gear by +1, apply tooth ratios, then add the arm's rotation to all rows and solve using the given conditions.

Unit 5: Belts, flywheels and governors

Definitions and short questions

- What are slip and creep in belt drives?
- Define centrifugal tension. What is the condition for maximum power transmission?
- Define coefficient of fluctuation of speed and coefficient of fluctuation of energy.
- Differentiate a flywheel and a governor.
- Define sensitiveness, stability, isochronism and hunting of governors.

Derivations

- Derive the ratio of belt tensions for a flat belt: $T1/T2 = e^{(\mu\theta)}$.
- Derive the condition for maximum power: $T1 = 3Tc$.
- Derive the height of a Watt governor: $h = g/\omega^2$.

Numericals

- A flat belt has μ = 0.3 and an angle of contact of 165°. The tight side tension is 1000 N and belt speed is 10 m/s. Find slack side tension and power, ignoring centrifugal tension. *Outline:* θ = 165 × π/180 ≈ 2.880 rad. T1/T2 = e^(0.3 × 2.880) ≈ 2.372. T2 ≈ **421.5 N**. P = (T1 − T2)v ≈ **5.79 kW**.
- A flywheel must limit speed fluctuation to ±1% of a mean speed of 300 rpm. The maximum fluctuation of energy is 5000 J. Find the moment of inertia. *Outline:* ω = 2π × 300/60 ≈ 31.42 rad/s, Cs = 0.02. I = ΔE/(ω²Cs) = 5000/(987 × 0.02) ≈ **253 kg·m²**.
- Find the height of a Watt governor at 60 rpm. *Outline:* ω = 6.283 rad/s. h = 9.81/6.283² ≈ **0.248 m**.

How to score well in Theory of Machines

- **Bring drawing tools.** Graphical answers need a scale, compass and set squares. State the scale on the diagram.
- **Name the method.** Write "relative velocity method" or "instantaneous centre method" before you start.
- **Use radians.** Belt and cam formulas need angles in radians.
- **Draw a table for epicyclic trains.** It is faster and examiners can follow it.
- **Explain with sketches.** Inversions and governors score better with a labelled diagram.
- **Leave time for drawing questions.** They take longer than formula questions.

Frequently asked questions

Are these Theory of Machines questions from previous year papers?

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

Which topics are most important in Theory of Machines?

Velocity analysis of slider-crank mechanisms, cam profiles, gear trains, belt tension ratio, flywheels and governors are common across most syllabi.

How do I prepare cam profile questions?

Draw the displacement diagram first, divide the angles equally, then transfer each displacement to the base circle. Practise with knife-edge and roller followers.

What is the easiest way to solve epicyclic gear trains?

Use the tabular method: fix the arm, rotate one gear by one turn, write the speeds of all gears, then add the arm's motion and apply the given conditions.

Is Theory of Machines the same as Kinematics of Machines?

Many universities split it: kinematics covers mechanisms, cams and gears, while dynamics covers flywheels, governors and balancing. Check your own syllabus.

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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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