Machine Design Important Questions PDF

The most important Machine Design topics are design procedure and factor of safety, theories of failure, fatigue with Goodman and Soderberg lines, riveted, welded and bolted joints, shafts under combined loading, keys and couplings, helical springs and rolling contact bearings. Practise design numericals step by step and always end by choosing a standard size.

Key takeaways

- These are practice questions based on common B.Tech syllabus topics. They are not verified past papers.
- Check your own university syllabus, official question papers and the design data book your university allows.
- Every design answer should end with a standard size, such as a rounded shaft diameter.
- Write the failure theory and factor of safety you use at the start of each numerical.
- Many universities split this subject into Machine Design I and II. Check which elements fall in your paper.

Before you start: about these questions

Machine Design is also called Design of Machine Elements. Most Indian B.Tech syllabi cover the topics below in one or two papers, and many allow a design data book in the exam. These are **practice questions based on common syllabus topics, not verified past papers**. 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 helps with cube roots in shaft design, and the unit converter with kW, N·m and MPa.

Unit 1: Design basics and theories of failure

Definitions and short questions

- State the general procedure of machine design.
- Define factor of safety. What factors decide its value?
- What is stress concentration? How can it be reduced?
- List the properties to consider when choosing a material for a machine part.
- What are preferred numbers, standardisation and tolerances?

Long questions

- Explain the maximum principal stress, maximum shear stress (Tresca) and distortion energy (von Mises) theories, and say which suits ductile and which suits brittle materials.
- Explain limits, fits and tolerances with the hole basis system.

Numerical

- A ductile material has a yield strength of 250 MPa. Find the allowable stress with a factor of safety of 2.5. *Outline:* $\sigma_allow = 250/2.5 =$ **100 MPa**.

Unit 2: Design for fluctuating loads (fatigue)

Definitions and short questions

- Define endurance limit and fatigue.
- Draw the S-N curve for steel.
- What factors modify the endurance limit (surface finish, size, reliability, temperature)?
- Define notch sensitivity and fatigue stress concentration factor.

Long questions

- Explain the Gerber, Goodman and Soderberg lines with a neat diagram, and say which is most conservative.
- Derive the Soderberg equation: $\sigma m/\sigma y + \sigma a/\sigma e = 1/N$.

Numerical

- A part has $\sigma y = 300$ MPa and corrected endurance limit $\sigma e = 200$ MPa. It carries mean stress 60 MPa and alternating stress 40 MPa. Find the factor of safety by Soderberg. *Outline:* $60/300 + 40/200 = 0.2 + 0.2 = 0.4$, so N = **2.5**.

Unit 3: Riveted, welded and bolted joints

Definitions and short questions

- Define pitch, margin and efficiency of a riveted joint.
- List the ways a riveted joint can fail.
- Differentiate butt and fillet welds. What is the throat of a fillet weld?
- Why is a bolt given initial tension?

Long questions

- Design a double riveted lap joint for given plate thickness and stresses, and find its efficiency.
- Derive the strength of a parallel fillet weld: $P = 2 \times 0.707 \times s \times l \times \tau$.
- Explain the design of an eccentrically loaded welded or bolted joint.

Numerical

- A plate is joined by two parallel fillet welds of size 10 mm. Load is 100 kN and allowable shear stress is 80 MPa. Find the weld length. *Outline:* $l = P/(2 \times 0.707 \times s \times \tau) = 100{,}000/(2 \times 0.707 \times 10 \times 80) \approx$ **88.4 mm** per weld. Add the start and stop allowance used in your textbook.

Unit 4: Shafts, keys and couplings

Definitions and short questions

- What are the types of shafts? List standard shaft sizes.
- Define equivalent twisting moment and equivalent bending moment.
- What is the function of a key? Compare sunk, saddle and feather keys.
- Differentiate rigid and flexible couplings.

Long questions

- Derive the shaft diameter for combined bending and torsion using the maximum shear stress theory: $d^3 = 16T_e/(\pi\tau)$, where $T_e = \sqrt{(M^2 + T^2)}$.
- Design a sunk key for a given shaft, checking for shear and crushing.
- Design a flange coupling or bushed-pin flexible coupling for given power and speed.

Numerical

- A shaft carries a bending moment of 1000 N·m and a torque of 1500 N·m. Allowable shear stress is 50 MPa. Find the diameter by the maximum shear stress theory. *Outline:* $T_e = \sqrt{(1000^2 + 1500^2)} \approx 1803$ N·m. $d^3 = 16 \times 1.803 \times 10^6/(\pi \times 50) \approx 183{,}600$ mm³, so d ≈ **56.8 mm**. Choose a standard size such as **60 mm**.

Unit 5: Springs and bearings

Definitions and short questions

- Define spring index, spring rate, solid length and free length.
- What is the Wahl stress factor and why is it used?
- Classify bearings. Compare sliding contact and rolling contact bearings.
- Define the basic dynamic load rating and rating life (L10) of a ball bearing.

Long questions

- Derive the stress and deflection equations for a closely coiled helical spring.
- Design a helical compression spring for a given load, deflection and allowable stress.
- Explain how to select a rolling contact bearing from a manufacturer's catalogue.

Numericals

- A helical spring has wire diameter 6 mm, mean coil diameter 48 mm and 10 active coils. G = 80 GPa. Find stiffness and the Wahl factor. *Outline:* $k = Gd^4/(8D^3n) = 80{,}000 \times 1296/(8 \times 110{,}592 \times 10)$ ≈ **11.7 N/mm**. $C = 48/6 = 8$, $K = (4C - 1)/(4C - 4) + 0.615/C$ ≈ **1.18**.
- A ball bearing has dynamic load rating C = 30 kN and equivalent load P = 5 kN. Find the rating life and life in hours at 1000 rpm. *Outline:* $L10 = (C/P)^3 = 6^3 =$ **216 million revolutions**. Hours = $216 \times 10^6/(60 \times 1000) =$ **3600 h**.

Common mistakes in Machine Design answers

- Using yield strength where the question needs endurance limit, or the other way round.

- Forgetting to convert kW and rpm into torque before shaft design.
- Mixing N·m and N·mm in the same formula. Convert the moment to N·mm when stress is in MPa.
- Skipping the stress concentration factor when the question gives a notch, shoulder or keyway.
- Giving an odd final size such as 56.8 mm instead of a standard size.

How to score well in Machine Design

- **Follow a design flow.** Given data, assumptions, material, failure theory, calculation, standard size, final check.
- **Quote the data book.** Write the table number when you take a value from it, if your university allows a data book.
- **Choose standard sizes.** Rounding up to a standard diameter shows design sense and often carries a mark.
- **Check the design.** After choosing a size, check stress or deflection again. Examiners reward the check.
- **Draw the element.** A neat sketch of a coupling, key or joint with dimensions adds marks.
- **Manage time.** Design questions are long. Attempt the ones you know fully before partial ones.

Frequently asked questions

Are these Machine Design 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.

Is a design data book allowed in the Machine Design exam?

Many universities allow a specific design data book, but rules differ. Confirm with your department or the paper instructions before the exam.

Which topics are most important in Machine Design?

Theories of failure, fatigue design with Soderberg or Goodman, welded and riveted joints, shaft design under combined loading, keys, couplings and helical springs are common.

Why should I round the shaft diameter up?

Shafts are made in standard sizes. Rounding up to the next standard size keeps the stress within the allowable limit and is what designers do in practice.

Which failure theory should I use for a ductile material?

Maximum shear stress or distortion energy theory is usual for ductile materials. Use the one the question asks for, or state your choice clearly.

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Sources and further reading

- AKTU old question papers (official)

- NPTEL courses
- Bureau of Indian Standards

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