GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

FUNDAMENTALS OF MACHINE DESIGN (3141907)

Unit 1: Basics of Stress and Strain

Repeated Questions:

1. **Define Hooke's law and explain with neat sketch for ductile materials.**
    - Appeared in: SUM 25 (Q3a, 03 marks), WIN 24 (Q4b-iv, 04 marks), WIN 23 (Q1b-i, 04 marks), SUM 22 (Q4a, 03 marks).
2. **Define/Explain Poisson's ratio, Bulk modulus, Modulus of rigidity.**
    - Appeared in: SUM 25 (Q4a-ii, 03 marks), WIN 24 (Q4b-i,ii,iv, 04 marks), WIN 23 (Q1b-ii,iii,iv, 04 marks), SUM 24 (Q1b, 04 marks), SUM 23 (Q1c, 07 marks), WIN 22 (Q3b, 04 marks).
3. **Derive the relation between the three elastic constants (E, G, K, μ).**
    - Appeared in: WIN 24 (Q1a, 03 marks), SUM 22 (Q2b, 04 marks).

Other Important Questions:

1. **Define the following terms: (i) Hooke's law (ii) Poisson's ratio (iii) Preferred series.**
    - Appeared in: SUM 25 (Q4a, 03 marks).
2. **Explain the terms: (1) Elasticity & Plasticity (2) Lateral strains & longitudinal strains.**
    - Appeared in: WIN 22 (Q3b, 04 marks).
3. **Explain volumetric stress and volumetric strain. Derive the expression to find the change in volume of a rectangular bar subjected to 3D stresses.**
    - Appeared in: SUM 23 (Q1c, 07 marks).
4. **Two wires, one of steel and the other of copper, are of the same length and are subjected to the same tension. If the diameter of the copper wire is 2 mm, find the diameter of the steel wire, if they are elongated by the same amount. Take E for steel as 200GPa and for copper as 100GPa.**
    - Appeared in: WIN 24 (Q3c, 07 marks).
5. **List the different types of stresses considered in machine design. And explain tensile and shear stress.**
    - Appeared in: SUM 22 (Q1a, 03 marks).
6. **Explain the following terms with neat sketches: (1) Tensile stress (2) Compressive stress (3) Principle Stress (4) Bearing pressure.**
    - Appeared in: WIN 22 (Q1b, 04 marks).

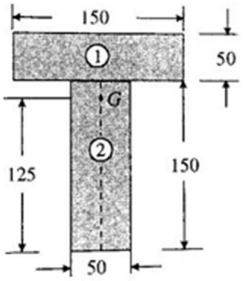
Unit 2: Moment of Inertia of Planar Cross-Sections

Repeated Questions:

1. **State/Explain Parallel and Perpendicular axes theorems.**
    - Appeared in: SUM 24 (Q1a, 03 marks), WIN 23 (Q2b, 04 marks), SUM 22 (Q4b, 04 marks).

Other Important Questions:

1. **Derive the expression for polar moment of inertia of a circle using principle of integration.**
    - Appeared in: SUM 23 (Q1a, 03 marks).
2. **Find the moment of inertia of a T section shown in the figure about X-X and Y-Y axes through the center of gravity of the section.**
    - Appeared in: WIN 24 (Q2c, 07 marks).



3. **Determine the moment of inertia for rectangular cross-section about X-axis and Y-axis passing from their CG.**
    - Appeared in: WIN 23 (Q4b, 04 marks).
4. **Determine the moment of inertia of plane section, shown in figure-1.**
    - Appeared in: WIN 22 (Q2b, 04 marks).

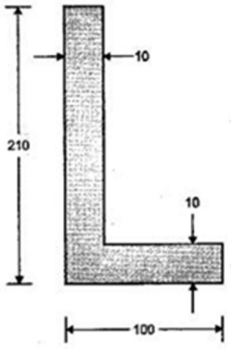


Figure :1 (Que: 2-B)

Unit 3: Flexural Stresses (Theory of Simple Bending)

Repeated Questions:

1. **Derive the equation for simple bending (σ/y = M/I = E/R). State the assumptions.**
    - Appeared in: SUM 25 (Q3b, 04 marks), SUM 24 (Q2a, 03 marks), SUM 22 (Q1b, 04 marks), WIN 22 (Q4b, 04 marks).
2. **Explain the assumptions made in theory of bending.**
    - Appeared in: WIN 24 (Q5a, 03 marks).

Other Important Questions:

1. **Derive an expression for bending stress in a straight beam subjected to bending moment.**
    - Appeared in: WIN 24 (Q1b, 04 marks).
2. **What is section modulus? Derive the expression of section modulus for rectangular section.**
    - Appeared in: SUM 23 (Q1b, 04 marks).
3. **A Steel beam section is of I section with top flange 80 x 20 mm thick, bottom flange 160 x 40 mm thick and web 200 mm deep and 20 mm thick. The beam is freely supported on span of 10 meters. If tensile stress is not to exceed 40 N/mm2. Find the safe uniformly distributed load which the beam can carry? Also find maximum compressive stress.**
    - Appeared in: SUM 24 (Q1c, 07 marks).
4. **I –section beam made of alloy steel (Figure-2) for which allowable bending and shear stresses are 200 N/ mm2. And 115 N/mm2 respective. If the modulus of elasticity for beam is 210 x 102 N/mm2, determine: (1) The maximum bending moments of beam (2) The maximum shear force (3) The maximum radius of curvature of the beam as it bends under maximum bending moment.**
    - Appeared in: WIN 22 (Q2c, 07 marks).

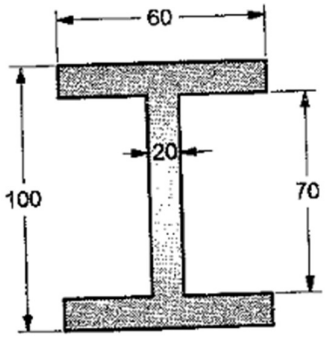


Figure: 2 (Que: 2-C)

5. **Distinguish stress distribution in curved and straight beams.**
    - Appeared in: SUM 23 (Q4b, 04 marks).

Unit 4: Torsion

Repeated Questions:

1. **Derive the torsion equation (T/J = τ/R = Gθ/L). State assumptions.**
    - Appeared in: SUM 24 (Q3c, 07 marks), SUM 22 (Q3b, 04 marks).

Other Important Questions:

1. **Define torsional rigidity. Derive an expression for angular deflection of a shaft subjected to twisting moment.**
    - Appeared in: WIN 24 (Q5b, 04 marks).
2. **Derive and explain the expression of polar modulus and polar moment of inertia of a solid shaft.**
    - Appeared in: SUM 23 (Q2b, 04 marks).
3. **Discuss torsion in solid shaft and hollow shaft.**
    - Appeared in: SUM 25 (Q4a, 03 marks).
4. **A steel wire of diameter d = 4 mm is bent around a cylindrical drum of radius R0 = 0.5 m, E = 200 GPa, σp = 1200 MPa. Determine M and σmax.**
    - Appeared in: SUM 23 (Q3c, 07 marks).

Unit 5: Introduction to Machine Design (Part of Unit-1 As per new Syllabus)

Repeated Questions:

1. **Explain the basic procedure for design of machine elements.**
    - Appeared in: SUM 25 (Q2b, 04 marks), WIN 23 (Q1a, 03 marks).
2. **Explain Manufacturing considerations in design.**
    - Appeared in: SUM 22 (Q1c, 07 marks), SUM 24 (Q3b, 04 marks), WIN 23 (Q2a, 03 marks).
3. **Discuss the importance of selection of materials in machine design. / Explain various aspects of materials selection in Machine Design.**
    - Appeared in: WIN 22 (Q2a, 03 marks), SUM 22 (Q3c, 07 marks).

Other Important Questions:

1. **Explain the design considerations in the casting.**
    - Appeared in: WIN 24 (Q1c, 07 marks).
2. **Explain the design considerations in casting process with neat sketch.**
    - Appeared in: SUM 23 (Q2a, 03 marks).
3. **Explain the ergonomic considerations in the controls and display.**
    - Appeared in: WIN 24 (Q4a, 03 marks).
4. **Explain Aesthetic and Ergonomic considerations in Design.**
    - Appeared in: Syllabus Outline.
5. **Define: Hardness, Ductility, Poisons ratio, Bulk Modulus.**
    - Appeared in: SUM 24 (Q1b, 04 marks).
6. **Define IS coding of steels and explain 45C8, 25Cr4Mo2, 10C8S10, SG80/2, FG60.**
    - Appeared in: SUM 24 (Q3a, 03 marks).
7. **Explain the effect of different alloying elements on the properties of steels.**
    - Appeared in: WIN 24 (Q5b, 04 marks).
8. **Find out the number of R5 basic series.**
    - Appeared in: SUM 24 (Q3a, 03 marks).

Unit 6: Design Against Static Load (Theories of Failure, Joints, Levers)

Repeated Questions:

1. **State and explain the different theories of failures. Explain Distortion energy (von Mises) theory / Maximum shear stress theory.**
    - Appeared in: SUM 25 (Q2b, 04 & 07 marks), SUM 24 (Q3c, 07 marks), WIN 23 (Q1c, 07 marks), WIN 22 (Q2c, 07 marks).
2. **Design a Knuckle joint to transmit XX kN. (Design parameters vary).**
    - Appeared in: SUM 25 (Q2c-OR, 07 marks - 150 kN), WIN 23 (Q2c, 07 marks - 150 kN), SUM 24 (Q4c, 07 marks - 25 kN), WIN 22 (Q3c, 07 marks - 25 kN), SUM 22 (Q2c, 07 marks - 70 kN).
3. **Design a Cotter joint (Spigot and Socket) for given load. OR Write design procedure.**
    - Appeared in: SUM 25 (Q1c, 07 marks & Q2c, 07 marks), WIN 23 (Q2c-OR, 07 marks), SUM 24 (Q4c, 07 marks), SUM 22 (Q2c-OR, 07 marks), WIN 22 (Q4a, 03 marks & Q4c, 07 marks).

Other Important Questions:

1. **What is key? What are the different types of key? / State the different types of keys.**
    - Appeared in: SUM 25 (Q2a, 03 marks), WIN 23 (Q3b, 04 marks), SUM 22 (Q3b, 04 marks).
2. **What is function of key in shaft? State their failure equations in brief.**
    - Appeared in: SUM 24 (Q2b, 04 marks).
3. **Derive strength equations of sunk key based on shear and crushing failures. Show that square key is equally strong in shearing and crushing compare to rectangular key.**
    - Appeared in: WIN 22 (Q4c, 07 marks).
4. **Design a square key for fixing a gear on shaft having 25 mm diameter. The gears rotates at 550 rpm and transmits 12 KW power to the meshing gear. The key is made of steel having yield strength in tension as 400 N/mm2. Assume factor of safety 2.5. Assume τs =0.577.**
    - Appeared in: SUM 24 (Q2c-OR, 07 marks).
5. **Explain the terms: Contact stresses and its examples. / What is contact stress? Explain Hertz contact stress.**
    - Appeared in: SUM 22 (Q3a, 07 marks), SUM 23 (Q3b, 04 marks).
6. **Define: Contact Stress.**
    - Appeared in: WIN 23 (Q5a-ii, 03 marks).
7. **Define: Leverage.**
    - Appeared in: WIN 23 (Q5a-i, 03 marks).
8. **What is lever? Why boss is provided at the fulcrum of lever?**

- Appeared in: SUM 24 (Q4a, 03 marks).

9. **Explain different types of sections normally used in the design of levers.**
   - Appeared in: SUM 23 (Q3a, 03 marks).
10. **Design a simple lever of a safety valve for a boiler having a gauge pressure of 1.5 MN/m2, the valve diameter is 90 mm. The lever is 1 m long and distance between the fulcrum and valve point is 100 mm... Assume lever section rectangle h/b is 4.**
    - Appeared in: SUM 24 (Q4c-OR, 07 marks).
11. **A bell crank lever is to be designed to lift the load of 75 kN acting at the end of short arm of the lever. The length of short arm and long arm is 100 mm and 500 mm respectively... Determine: (1) dimension of the fulcrum pin (2) dimensions of lever.**
    - Appeared in: SUM 22 (Q4c, 07 marks).
12. **Design a right angled bell crank lever. The horizontal arm is 500 mm long and a load of 4.5 kN acts vertically downward... Take Safe stress in tension = 75 MPa, Safe stress in shear = 60 MPa, Safe bearing pressure on pins = 10 N/mm2.**
    - Appeared in: WIN 23 (Q5c, 07 marks).
13. **Explain basic type of lever with neat sketches.**
    - Appeared in: WIN 22 (Q3a, 03 marks).
14. **Differentiate between crushing and bearing stresses.**
    - Appeared in: WIN 24 (Q3b-a, 04 marks).
15. **Differentiate between torsional and transverse shear stress.**
    - Appeared in: WIN 24 (Q3b-b, 04 marks).

Unit 7: Shafts and Keys

Repeated Questions:

1. **Design a shaft subjected to torque/bending/combined loading.**
    - Appeared in: SUM 24 (Q2c, 07 marks), WIN 23 (Q3c, 07 marks), SUM 22 (Q3c, 07 marks), WIN 24 (Q2c-OR, 07 marks).
2. **Compare/Discuss Hollow shaft and Solid shaft. / How the hollow shafts are beneficial over the solid shaft?**
    - Appeared in: SUM 25 (Q5a, 03 marks), WIN 22 (Q3a, 03 marks).

Other Important Questions:

1. **Derive the design equation for shaft subjected to twisting moment only.**
    - Appeared in: WIN 22 (Q3b, 04 marks).
2. **Derive the expression of design of shaft subjected to combined twisting moment and bending moment with usual notations.**
    - Appeared in: SUM 23 (Q3c, 07 marks).
3. **Determine the diameter of a solid shaft used for transmitting 30 kW power at 230 r.p.m. determine the diameter of hollow shaft, if the solid shaft is to be replaced by the hollow shaft. Take the ratio of inside to outside diameter is 6:8 and allowable shear stress of shaft as 50 MPa.**
    - Appeared in: WIN 22 (Q3c, 07 marks).
4. **A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is subjected to a twisting moment of 120 N-m, simultaneously; it is subjected to an axial thrust of 10 kN and a bending moment of 80 N-m. Calculate the maximum compressive and shear stresses.**
    - Appeared in: SUM 25 (Q4c, 07 marks).
5. **45 mm diameter shaft is made of steel with a yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 340 MPa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2.**
    - Appeared in: SUM 25 (Q5c, 07 marks).
6. **What is spline? Explain different types of splines.**
    - Appeared in: SUM 23 (Q3a, 03 marks).
7. **Differentiate between shaft, spindle and axle.**
    - Appeared in: SUM 22 (Q3a, 03 marks), WIN 23 (Q3a, 03 marks), WIN 24 (Q3a, 03 marks).

Unit 8: Power Screws and Threaded Joints

Repeated Questions:

1. **Explain the terms: Self-locking and overhauling of power screw. State the condition.**
    - Appeared in: SUM 25 (Q5a, 03 marks), WIN 24 (Q2a, 03 marks), WIN 23 (Q3a, 03 marks), SUM 22 (Q5a, 03 marks), WIN 22 (Q5b, 04 marks).
2. **Derive an equation for finding torque required to raise the load by square threaded screws.**
    - Appeared in: WIN 23 (Q4b, 04 marks), SUM 22 (Q5b, 04 marks).
3. **Numerical on Power Screw: Find torque, power, efficiency for given load and thread parameters.**
    - Appeared in: SUM 25 (Q3c, 07 marks & Q4c-OR, 07 marks), WIN 24 (Q4c, 07 marks & Q5c, 07 marks), WIN 23 (Q3c, 07 marks), SUM 24 (Q5c, 07 marks), SUM 23 (Q5c, 07 marks).
4. **Explain the different types of screw threads used in power screw / Discuss various types of power threads.**
    - Appeared in: SUM 22 (Q5b, 04 marks), WIN 24 (Q4a-OR, 03 marks).
5. **Explain any three/four Terminology of power screw with figure.**
    - Appeared in: WIN 23 (Q4a, 03 marks), WIN 22 (Q5b, 04 marks).
6. **Explain: (1) Pitch (2) Lead (3) Nominal diameter (4) Core diameter for Power screw.**
    - Appeared in: SUM 25 (Q4b, 04 marks).
7. **Why square threads are preferable to V thread for power transmission?**
    - Appeared in: WIN 22 (Q1c, 07 marks).

Other Important Questions:

1. **Prove that efficiency of self-locking square thread is less than 50%.**
    - Appeared in: WIN 22 (Q4b, 04 marks).
2. **Classify the basic types of screw fastening. Differentiate between bolt and screw.**
    - Appeared in: WIN 24 (Q4b, 04 marks).
3. **Discuss the advantages and disadvantages of threaded joints.**
    - Appeared in: SUM 24 (Q5a-OR, 03 marks).
4. **Explain different types of welded joints with neat sketches.**
    - Appeared in: SUM 22 (Q4a, 03 marks).
5. **The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory. Take permissible tensile stress at elastic limit = 100 MPa and poisson's ratio = 0.3.**

- Appeared in: WIN 23 (Q4c, 07 marks).

6. **Justify that "Preloading improves the fatigue strength of bolted joint."**
   - Appeared in: SUM 23 (Q4a-OR, 03 marks).

Unit 9: Design Against Fluctuating Loads

Repeated Questions:

1. **What is endurance limit/strength? Discuss the factors affecting it.**
    - Appeared in: SUM 25 (Q5b, 04 marks), WIN 23 (Q4a-i, 03 marks), WIN 22 (Q5c, 07 marks), SUM 24 (Q5b-OR, 04 marks).
2. **Explain Soderberg, Goodman, and Gerber theories/lines/diagrams.**
    - Appeared in: SUM 22 (Q5a, 03 marks), WIN 24 (Q5c, 07 marks), WIN 23 (Q4c, 07 marks & Q5b, 04 marks).
3. **What is stress concentration? State reasons and methods to reduce it.**
    - Appeared in: SUM 25 (Q4b, 04 marks), WIN 24 (Q5c, 07 marks), SUM 24 (Q5a, 03 marks), SUM 23 (Q5b, 04 marks), WIN 22 (Q5b, 04 marks).

Other Important Questions:

1. **Explain with figure a. Fluctuating stresses b. Repeated stresses c. Reversed stresses.**
    - Appeared in: WIN 22 (Q5a, 03 marks).
2. **Explain different types of Fatigue stresses with stress–time curves.**
    - Appeared in: SUM 23 (Q5a, 03 marks).
3. **Explain cumulative fatigue damage with Minor's Equation.**
    - Appeared in: SUM 23 (Q5b, 04 marks).
4. **Derive Soderberg's equation and state its application to different types of loadings.**
    - Appeared in: WIN 22 (Q5c, 07 marks).
5. **A machine component is subjected to fluctuating stress that varies from 40 to 100 N/mm2. The corrected endurance limit stress for the machine component is 270 N/mm2. The ultimate tensile strength and yield strength of the material are 600 and 450 N/mm2 respectively. Find the factor of safety using (i) Gerber theory (ii) Soderberg line (iii) Goodman line.**
    - Appeared in: WIN 24 (Q5c, 07 marks), WIN 23 (Q4c, 07 marks).
6. **A steel rod is subjected to a reversed axial load of 200 KN. Find the diameter of rod for factor of safety 2... The endurance limit in reversed bending may be assumed to be half of ultimate tensile strength. The correction factor may be taken as follows. Ka = Axial load correction factor =0.7, for machined surface factor =0.8, size factor =0.85, stress concentration factor is 1.0.**
    - Appeared in: SUM 24 (Q5c-OR, 07 marks).
7. **The endurance strength for a part is 280 MPa while Su = 630 MPa. It is subjected to a loading as follows: σ_{m1} = 315 MPa, σ_{v1} = 96 MPa for 80% of time; σ_{m2} = 245 MPa, σ_{v2} = 145 MPa for 20% of time. Find the expected life in number of cycles of reversals. Assume Kt = 1.5.**
    - Appeared in: SUM 23 (Q5c, 07 marks).

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