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Question Paper Code : 60921

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Fifth/Sixth Semester

Mechanical Engineering

ME8593 — DESIGN OF MACHINE ELEMENTS

(Common to: Automobile Engineering/Industrial Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the significance of stress concentration?
2. Mention any two modes of mechanical failure.
3. State the equation for torsional shear stress in solid shafts.
4. Define torsional rigidity.
5. Name the different types of welded joints used in machine design.
6. Differentiate between temporary and permanent joints.
7. Define torsional stiffness in the context of engine components.
8. Define spring index.
9. Write any two types of rolling contact bearings.
10. What is the purpose of lubrication in bearings?

PART B — ($5 \times 13 = 65$ marks)

11. (a) (i) Explain the design criteria for machine members subjected to fluctuating loads. (4)

- (ii) A mild steel bar of 25 mm diameter is subjected to an axial load of 30 kN. Calculate the induced stress and check if it is within safe limits for a yield stress of 250 MPa with a factor of safety of 2.5. (9)

Or

- (b) (i) Calculate the principal stresses for a component subjected to 60 MPa tensile and 30 MPa compressive stresses. (4)

- (ii) A component is subjected to a fluctuating tensile load varying from 20 kN to 60 kN. The endurance limit is 140 MPa and yield strength is 250 MPa. Determine the factor of safety using Soderberg criterion. Assume $K_t = 1.5$, $K_f = 1.5$, and diameter = 30 mm. (9)

12. (a) (i) Design a hollow shaft with external diameter twice the internal diameter to transmit 100 kW at 300 rpm. The maximum shear stress is 50 MPa. (10)

- (ii) Describe the method for calculating critical speed of a shaft. (3)

Or

- (b) (i) Explain the design consideration for shaft subjected to combined bending and torsion. (4)

- (ii) A shaft of 45 mm diameter is connected using a key. Determine the dimensions of the rectangular key and check for failure in shear and crushing. Torque transmitted is 400 Nm. (9)

13. (a) (i) Differentiate between knuckle and riveted joints with applications. (4)

- (ii) A bolted joint is subjected to an eccentric load of 12 kN with 4 bolts placed in a rectangular pattern. Determine the load on each bolt and check for safety. (9)

Or

- (b) (i) Determine the strength of a welded joint subjected to axial load. (4)

- (ii) A double riveted lap joint with plates of 10 mm thickness is to be designed for a load of 80 kN. Determine the rivet diameter, pitch, and number of rivets. (9)

14. (a) (i) Derive the expression for stress in circular springs. (4)

- (ii) A connecting rod is subjected to axial force of 25 kN. Cross-section dimensions are 30 mm $\times$ 40 mm. Calculate the induced stress and check safety for yield strength of 250 MPa. (9)

Or

- (b) (i) Determine the deflection of a cantilever spring for load and dimensions. (4)
- (ii) A helical spring is to carry a load of 1000 N with a deflection of 25 mm. The spring index is 6 and the wire diameter is 10 mm. Find the number of active coils and spring stiffness. (9)
15. (a) (i) Discuss about the bearing characteristic number and its influence. (4)
- (ii) A journal bearing supports a shaft of 50 mm diameter rotating at 900 rpm. Bearing length = diameter. Load = 2.5 kN. Viscosity = 20 cP. Clearance = 0.05 mm. Calculate Sommerfeld number. (9)
- Or
- (b) (i) Describe briefly about the selection procedure for a ball bearing subjected to radial and axial loads. (4)
- (ii) A roller bearing is subjected to a radial load of 4 kN and axial load of 1 kN. Determine the equivalent dynamic load and bearing life for a rated life of 10^8 revolutions. (9)

PART C — ($1 \times 15 = 15$ marks)

16. (a) (i) A simply supported beam of length 2 m carries a uniformly distributed load of 5 kN/m. Calculate the maximum bending stress if the cross-section of the beam is 100 mm $\times$ 150 mm. Also, compute the factor of safety if yield strength is 250 MPa. (6)
- (ii) Design a hollow shaft of 1.2 m length to transmit 50 kW at 120 rpm. The external and internal diameters are in the ratio 2:1. The allowable shear stress is 50 MPa. Determine the shaft dimensions. (9)
- Or
- (b) (i) Design a helical compression spring to carry a load of 1000 N, with a deflection of 25 mm. Take the spring index as 6 and the allowable shear stress as 400 MPa. Calculate wire diameter, mean coil diameter, number of active coils, and total length of the spring. (12)
- (ii) A closed-coil helical spring is made of wire of 10 mm diameter and has a mean diameter of 100 mm. It is subjected to an axial load of 500 N. Calculate the maximum shear stress and deflection. (3)

