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Question Paper Code : 81659

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Fifth Semester

Mechanical Engineering

ME 3591 — DESIGN OF MACHINE ELEMENTS

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

(Use of PSG Design Data book is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define unilateral and bilateral tolerance.
2. List the modes of failure in mechanical design.
3. What types of stresses are induced in shafts?
4. Classify the types of couplings used in power transmission.
5. State the conditions for eccentric loading in bolted joints.
6. What are the advantages of welded joints compared with riveted joints?
7. Two springs of stiffness K_1 and K_2 are connected in series. What is the stiffness of connection?
8. Mention any one method for avoiding the tendency of a compression spring to buckle.
9. Give two application where the inner race is rotating and outer race is stationary in rolling contact bearings.
10. Name the material that is used to make ball bearings.

PART B — ($5 \times 13 = 65$ marks)

11. (a) A bolt is subjected to an axial force of 20000 N with transverse shear force of 10000 N. Find the diameter of the bolt required according to all 5 theories of failure. It is assumed that the permissible tensile stress at elastic limit = 120 N/mm^2 and Poisson's ratio = 0.29.

Or

- (b) A mild steel shaft of 60 mm diameter is subjected to a bending moment of 3000 N-m and a torque T. If the yield point of the steel in tension is 300 MPa. Find the maximum value of this torque without causing yielding of the shaft according to:
- (i) Maximum Normal stress theory
 - (ii) Maximum shear stress theory
 - (iii) Distortion Energy theory
 - (iv) Maximum strain energy theory of yielding.
12. (a) Two 30 mm shaft are connected by a flanged coupling. The flanges are fitted with 6 bolts on 150 mm bolt circle. The shafts transmit a torque of 900 N-m at 450 rpm. For the safe stresses mentioned below, calculate
- (i) Diameter of bolts;
 - (ii) Thickness of flanges;
 - (iii) Key dimensions;
 - (iv) Hub length; and
 - (v) Power transmitted.

Safe shear stress for the shaft material = 60 MPa; Safe stress for bolt material = 56 MPa; Safe stress for cast iron coupling = 10 MPa; Safe stress for key material = 50 MPa.

Or

- (b) A steel solid shaft transmitting 25 kW at 400 r.p.m. is supported on two bearings 800 mm apart and has two gears keyed to it. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of the right hand bearing and delivers power horizontally to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in a vertical direction from below. Using an allowable stress of 50 MPa in shear, determine the diameter of the shaft.

13. (a) A 50 mm diameter solid shaft is welded to a flat plate as shown in fig 1. if the size of the weld is 10 mm; Calculate the maximum normal and shear stress in the weld.

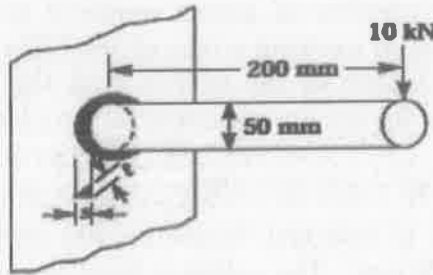


Fig. 1

Or

- (b) Design and draw a cotter joint to support a load varying from 40 kN in compression to 40 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. Tensile stress = compressive stress = 40 MPa; shear stress = 45 MPa and crushing stress = 90 MPa.
14. (a) Design a closed coiled helical compression spring for a load range varying from 2.50 kN to 2.95 kN and corresponding axial deflection of 6 mm. Spring index is 5. Permissible shear stress is 400 N/mm² and modulus of rigidity is 80 kN/mm².

Or

- (b) A 6 kW induction motor, running at 900 rpm operates a riveting machine. The flywheel fitted to it, is of mass 110 kg, with radius of gyration equal to 0.35 m. Each riveting takes 1 second and requires 9 kW. Determine (i) the number of rivets formed per hour and (ii) the reduction in speed of the flywheel, after the riveting operation.
15. (a) The load on the journal bearing is 160 kN due to turbine shaft of 320 mm diameter-running at 2000 rpm. Determine the following. Length of the bearing if the allowable bearing pressure is 1.6 N/mm² and amount of heat to be removed by the lubricant per minute if the bearing temperature is 60°C and viscosity of the oil at 60°C is 0.02 kg/m.s and the bearing clearance is 0.30 mm.

Or

- (b) Design a suitable connecting rod for a petrol engine for the following details: Diameter of the piston = 150 mm; Weight of reciprocating parts per cylinder = 25 N; Connecting rod length = 350 mm; Compression ratio = 7:1; Maximum explosion pressure = 3 N/mm²; Stroke = 140 mm; Speed of the engine = 2000 rpm.

PART C — ($1 \times 15 = 15$ marks)

16. (a) A semi-elliptical laminated spring 800 mm long and 50 mm wide is held together at the centre by a band 50 mm wide. If thickness of each leaf is 5 mm, find the number of leaves required to carry a load of 4000 N. Assume a maximum working stress of 480 MPa. If the two of these leaves extend the full length of the spring, find the deflection of spring. The Young's modulus for the spring material may be taken as 210 kN/mm².

Or

- (b) A steam engine of effective diameter 400 mm is subjected to a steam pressure of 1.5 N/mm². The cylinder head is connected by 8 bolts having yield point 300 MPa and endurance limit at 250 MPa. The bolts are tightened with an initial preload of 1.5 times the steam load. A soft copper gasket is used to make the joint leak-proof. Assuming a factor of safety 2, find the size of bolt required. The stiffness factor for copper gasket may be taken as 0.5.