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10MA53

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Design of Machine Elements

Time: 3 hrs. Max. Marks:100

Note: 1. *Answer any FIVE full questions, selecting at least TWO questions from each part.*
2. *Any missing data may be assumed suitably.*
3. *Use of Design Data handbook is permitted.*

PART – A

1 a. Explain the following Theories of failure
i) Maximum Normal stress theory
ii) Maximum shear stress theory
iii) Distortion energy theory **(12 Marks)**

b. A bar of 50mm diameter fixed at one end is subjected to tornsinal load of 1kN-m in addition to an axial pull of 15kN. Determine the principal stresses if the length of the shaft is 250mm. **(08 Marks)**

2 a. Derive Soderberg's relation, explain the significance of it. **(08 Marks)**

b. A steel rod (SAE 9260 oil quenched σ_{ut} = 1089.5MPa, σ_{yt} = 689.4MPa, σ_{-1} = 427.6 MPa) is subjected to a tensile load which varies from 120kN to 40kN. Design the safe diameter of the rod using Soderberg equation. Take FOS = 2, stress concentration factor as unity and correction factors for load, size and surface as 0.75, 0.85 and 0.91 respectively. **(12 Marks)**

3 a. Derive instantaneous stress due to axial impact. **(10 Marks)**

b. Design a protected type flange coupling to transmit power between two shafts 40mm and 50mm. The allowable stress for shaft and bolts is 60MPa. The allowable stress and bearing stress for key are 54MPa and 120 MPa respectively. For CI flange, the allowable shear stress is 6MPa assume keyway factor = 0.75. **(10 Marks)**

4 A horizontal piece of commercial shafting is supported by two bearings 1.5m apart. A keyed gear 20° involute and 175mm in diameter is located 400mm to the left of right bearing and is driven by a gear directly behind it. A 600mm diameter pulley is keyed to the shaft 600mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3:1, with the slack side on top. The drive transmits 45kW at 330rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft.
Use, τ_{all} = 40MPa, G = 80×10^9 N/mm^2. **(20 Marks)**

PART – B

5 a. Derive Lewis equations for tangential tooth load for spur gear. **(06 Marks)**

b. Design a pair of spur gears to transmit a power of 18kW from a shaft running at 1000 rpm to a parallel shaft to be run at 250 rpm maintain a distance of 160mm between the shaft centers. Suggest suitable surface hardness for the gear pair. Assume $\alpha = 20°$ FDI, C_s = 1.5, σ_{01} = 500MPa, σ_{02} = 379MPa, z_1 = 20. **(14 Marks)**

6 a. Design a Knuckle joint to connect two round rods of 42mm diameter. The ultimate strength of rods in tension is 420MPa. Ultimate compressive and shear stresses for the material are 510 MPa and 306 MPa respectively. Take FOS = 6. **(10 Marks)**

b. Design a triple riveted lap joint zig-zag type for a pressure vessel of 1.5m diameter. The maximum pressure inside the vessel is 1.5MPa. The allowable stresses in tension, crushing and shear are 100, 75 and 125MPa respectively. **(10 Marks)**

7 a. Derive shear stress in Helical compression spring and write the shear stress distribution diagram. **(10 Marks)**

b. Design a valve spring for an automobile engine, when the valve is closed, the spring produces a force of 45N and when it opens, produces a force of 55N. The spring must fit over the valve bush which has an outside diameter of 20mm and must go inside a space of 35mm. The lift of valve is 6mm. The spring index is 12. τ_{all} = 0.33 GPA, G = 80GPa. **(10 Marks)**

8 a. Explain Hydrodynamic theory of lubrication with respect to journal bearing. **(08 Marks)**

b. A lightly loaded journal bearing has a load of 1kN. The oil used is SAE 60 and mean effective temperature of operation is 40°C. The journal has a diameter of 50mm and the bearing has a diameter of 50.5mm. The speed of journal is 15000 rpm. The $\frac{L}{d}$ ratio is limited to 1.2. Determine the coefficient of friction and power loss due to friction. Assume full journal bearing. **(12 Marks)**

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