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06ME52

Fifth Semester B.E. Degree Examination, December 2010
Design of Machine Elements - I

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of design data handbook is permitted.***

PART – A

1 a. Sketch and explain biaxial, triaxial and principal stresses. **(08 Marks)**

b. A bracket shown in Fig.Q1(b) is subjected to a pull of 15 kN at 60° to the vertical. Determine the maximum tensile stress in the bracket. **(12 Marks)**

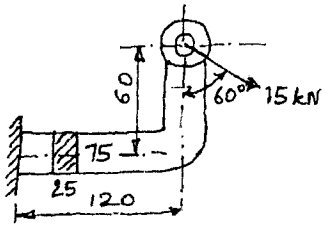

Fig.Q1(b)

2 a. A steel cantilever beam of rectangular cross section is loaded 400 mm from the support. The width of the beam is 15 mm and depth is 20 mm. Determine the maximum bending stress in the beam, when a weight of 100 N is dropped on the beam through a height of 5 mm. Take E = 210 GPa. **(06 Marks)**

b. A cylindrical shaft made of steel is subjected to static load, consisting of bending moment of 10 kN-m and a torsional moment of 30 kN-m. Determine the dia of the shaft according to :
i) Maximum shear stress theory ii) Shear energy theory.
Take yield strength = 700 MPa. Young's modulus = 210 GPa, Poisson's ratio = 0.25. Factor of safety = 2. **(14 Marks)**

3 a. Derive Soderberg's design equation for members subjected to variable stresses. **(06 Marks)**

b. A hot rolled steel shaft is subjected to a torsional load that varies from 330 Nm clockwise to 110 Nm counter claockwise, as an applied bending moment at a critical section, varies from 440 Nm to –220 Nm. Determine the required shaft diameter. The ultimate strength of the material is 550 MPa and yield stress is 410 MPa. Design factor of safety is 1.5. Take endurance limit as half the ultimate strength and size factor B = 0.85. Neglect the effect of stress concentration. **(14 Marks)**

4 a. Explain various types of stresses in threaded fasteners. **(06 Marks)**

b. Suggest the suitable size of bolts, if the bracket shown in Fig.Q4(b) is subjected to a load of 20 kN at 60° from the vertical. The allowable tensile stress in the bolts is 120 MPa. The bracket is fixed using 4 bolts. **(14 Marks)**

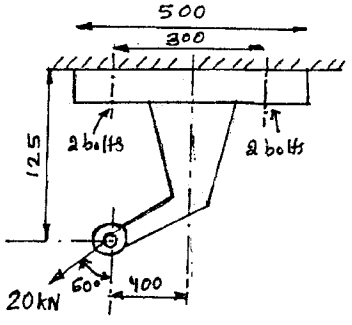

Fig.Q4(b)

PART – B

5 A horizontal steel shaft, supported on bearings A at the left end and B at the right end, carries two gears C and D, located at distances 250 mm and 400 mm respectively, from the center lines of left and right end bearings. The pitch diameter of gear C is 600 mm and that of gear D is 200 mm. The pressure angle is 20°. The distance between the center lines of the bearings is 2400 mm. The shaft transmits 20 kW power at 120 rpm. The power is delivered to the shaft at gear C and is taken out at gear D in such a manner that the tooth pressures F_{-C} and F_{+D} of gears C and D act vertically downwards. Find the diameter of the shaft, if the working stresses are 100 MPa in tension and 56 MPa in shear. The gears C and D weigh 950 N and 350 N respectively. Take $C_m = 1.5$ and $C_T = 1.2$. **(20 Marks)**

6 a. Design a square key for fixing a gear on a shaft of 25 mm diameter. 15 kW power at 720 rpm is transmitted from the shaft to the gear. The allowable compressive stress in the material is 150 MPa and allowable shear stress is 88 MPa. **(06 Marks)**

b. Design a Knuckle joint for a tie rod of circular cross section to sustain a maximum tensile load of 70 kN. The ultimate strength of the rod against tension is 420 N/mm^2. The ultimate tensile and shearing stresses for the pin material are 500 N/mm^2 and 360 N/mm^2 respectively. Take a factor of safety of 6. **(14 Marks)**

7 a. Determine the size of the weld required for a flat plate, welded to a steel column and loaded as shown in Fig.Q7(a). The allowable shear stress in the weld is limited to 80 MPa at the throat section. **(10 Marks)**

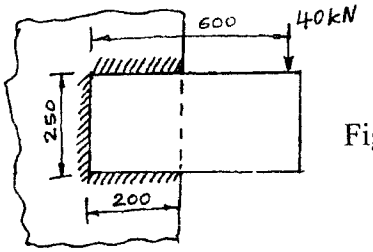

Fig.Q7(a)

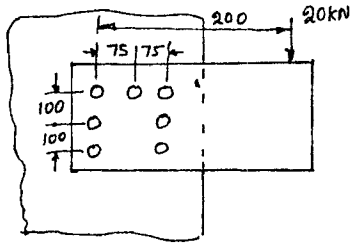

Fig.Q7(b)

b. Determine the size of rivets, for the 20 mm thick flat plate, riveted to a column as shown in Fig.Q7(b). The allowable stresses in the rivets are 56 MPa in shear and 100 MPa in crushing. **(10 Marks)**

8 a. Explain the terms 'overhauling' and 'self locking' with respect to power screws. **(05 Marks)**

b. The screw of shaft straightner exerts a load pf 30 kN as shown in Fig.Q8(b). The screw is square threaded of outside diameter 75 mm and 6 mm pitch. Determine :

i) Force required at the rim of 300 mm diameter hand wheel assuming the coefficient of friction for threads as 0.12.

ii) Maximum compressive stress in the screw, bearing pressure on the threads and maximum shear stress in threads.

iii) Efficiency of the straightner. **(15 Marks)**

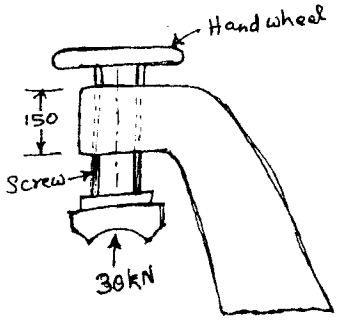

Fig.Q8(b)

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