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10ME/AU52

Fifth Semester B.E. Degree Examination, May 2017
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions, selecting atleast TWO questions from each part.***
2. Use of Design data handbook is permitted.
3. Assume any missing data suitably.

PART – A

1 a. What is mechanical engineering design? Explain the steps involved in Design with a block diagram. **(06 Marks)**

b. A machine element on the form of a cantilever beam has a rectangular cross-section of depth 200 mm. This beam is subjected to an axial tensile load of 60 kN and a transverse load of 50 kN acting downwards at the free end of the beam, which has a span of 800 mm. Determine the width of the rectangular cross-section, if the machine element if made up of steel with an allowable tensile stress of 80 N/mm^2. **(08 Marks)**

c. Sketch and explain Biaxial and Tri-axial stresses, principal stresses. **(06 Marks)**

2 a. Explain the following theories of failure:
(i) Maximum normal stress theory
(ii) Maximum shear stress theory **(04 Marks)**

b. A stepped shaft with its diameter reduced from '1.5d' to 'd' has a fillet radius of 0.1d. Determine the diameter of the shaft and the radius of the fillet to transmit a power of 65 kW at a rated speed of 1440 rpm limiting the max shear stress induced to 60 MPa. **(08 Marks)**

c. A beam of 400 mm depth I-section is resting on two supports 6 m apart. It is loaded by a weight of 5000 N falling through a height of 10 mm and striking the beam at mid-point. Moment of inertia of the section is 12×10^7 mm^4. Take E = 2×10^5 N/mm^2. Determine
(i) Impact factor (ii) Instantaneous max. stress (iii) Instantaneous max. deflection
(iv) (ii) Instantaneous max. load. **(08 Marks)**

3 a. Derive Soderberg's relation for a member subjected to fatigue loading. **(06 Marks)**

b. A 40 mm diameter steel shaft has σ_y = 413 MPa , σ_{en} = 336 MPa. For a factor of safety of N = 2. What (i) repeated (ii) reversed, torques can the shaft sustain indefinitely? The shaft has a groove machined on it. The radius of the groove is 2 mm and the diameter at the bottom of the groove is 36 mm. Take size factor = 0.85, Surface factor = 1. **(14 Marks)**

4 a. A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A copper asbestos gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto the pressure vessel. Find the size of bolts so that the allowable stress is not to exceed 100 MPa. **(10 Marks)**

b. For the eccentrically loaded bracket with M20 bolts shown in Fig.Q4(b). Calculate the maximum load that can be applied if the allowable tensile stress in the bolt is limited to 90 MPa. **(10 Marks)**

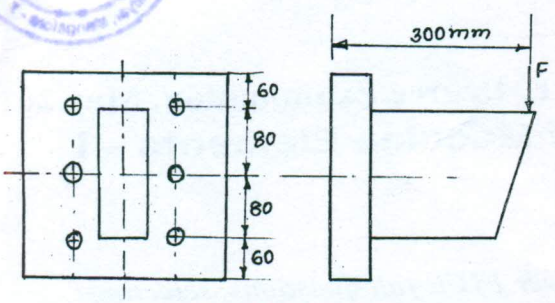

Fig.Q4(b)

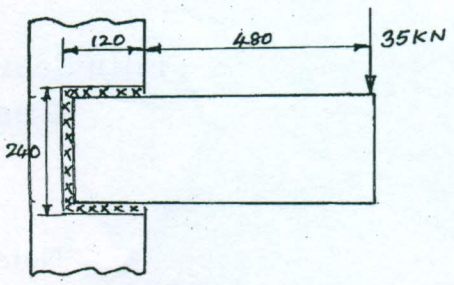

Fig.Q7(b)

PART – B

5 A horizontal commercial shaft is supported between two bearings 1500 mm apart. A gear of 20° involute and 200 mm in diameter is located 400 mm to the left of right bearing and is driven by a gear directly behind it. A 600mm diameter pulley is located on the shaft 600 mm to right of left bearing and drives a pulley with a horizontal belt directly in front of it. The tension ratio of the belt is 3:1, with the right side on top. The drive transmits 50 kW at 350 rpm. Take $K_b = K_t = 1.5$. calculate the diameter of the solid shaft required with an allowable shear stress of 60 MPa. Use max. shear stress theory. **(20 Marks)**

6 a. Prove that a square key is equally strong in shear and compression. **(04 Marks)**

b. A splined connection in an automobile transmission consists of 10 splines cut in 58 mm diameter shaft. The height of each spline is 5.5mm and key ways in the hub are 45mm long. Determine the power that may be transmitted at 2500 rpm. Allowable normal pressure on spline is limited to 5 MPa. **(06 Marks)**

c. Design a flange coupling to connect the shaft of a motor and centrifugal pump for the following specifications:
Pump output = 3000 ltrs/mm ; Total head = 20 m , Pump speed = 600 rpm
Pump efficiency = 70% , Select C-40 steel (σ_y = 328.6 MPa) for shaft, bolts and keys with factor of safety 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm^2. **(10 Marks)**

7 a. Design a longitudinal double riveted double strap butt joint with unequal straps for a pressure vessel. The internal diameter of the pressure vessel is 1 m and is subjected to an internal pressure of 2.2 N/mm^2. The pitch of the rivet in the outer row is to be double the pitch in the inner row. The allowable tensile stress in the plate is 124 N/mm^2. The allowable shear and crushing of the rivets are 93 N/mm^2 and 165 N/mm^2 respectively. The resistance of the rivets in double shear is to be taken as 1.875 times that of single shear. **(10 Marks)**

b. Determine the required fillet weld size for the bracket loaded as shown in Fig.Q7(b). Take allowable stress for weld material as 60 MPa. **(10 Marks)**

8 a. What is self locking of screw? What is the condition for self locking? State the applications where self-locking is essential. **(06 Marks)**

b. A single start square threaded power screw is used to raise a load of 120 kN. The screw has a mean dia of 24 mm and pitch 6 mm. The mean collar diameter is 40 mm. The coefficient of friction is 0.1 for both the thread and the collar. Determine
(i) Major diameter of the screw
(ii) Torque required to raise the load
(iii) Overall efficiency. **(14 Marks)**

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