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10ME52

Fifth Semester B.E. Degree Examination, June/July 2019
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 machine design data hand book permitted.***
3. ***Missing data may be suitably assumed.***

PART – A

1 a. What is Mechanical Engineering Design? Explain. **(04 Marks)**

b. Explain the importance of standards in design. List different types of standards in use. **(04 Marks)**

c. A machine member made of a steel bar of 50 mm dia. is as shown in Fig. Q1 (c). It is subjected to a vertical load of 4 kN as shown. Indicate the critical point and determine principal stresses at the critical point. **(12 Marks)**

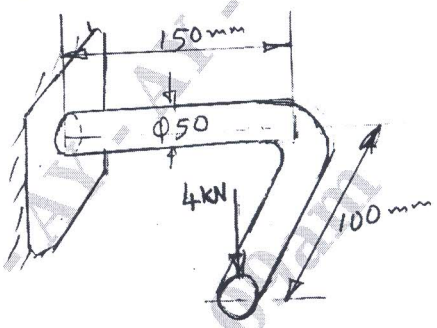

Fig. Q1 (c)

2 a. State and explain following theories of failure:
(i) Maximum normal stress theory.
(ii) Maximum shearing stress theory. **(04 Marks)**

b. A round rod made of steel C30 is subjected to bending moment of 2 kN-m and a twisting moment of 1.5 kN-m. Factor of safety is 2.5. Determine the diameter of the rod according to:
(i) Max. shear stress theory of failure and
(ii) Max. distortion energy theory of failure. . **(08 Marks)**

c. A mass of 15 kg falls from a height of 250 mm at the midpoint of a simply supported beam. It is made of steel, has a length of 1 m between the supports. Cross section of the beam is 60mm × 60mm square. Determine maximum deflection and bending stress induced in the beam due to falling mass. **(08 Marks)**

3 a. Explain :
(i) Stress concentration factor and methods to reduce effect of stress concentration.
(ii) Low cycle and high cycle fatigue.
(iii) Size and surface finish factors in fatigue design. **(06 Marks)**

b. A pulley is keyed to a shaft midway between two bearings. The shaft is made of C40 steel. At the mid section bending moment varies from −300 N-m to +500 N-m and the torque varies from −100 N-m to +200 N-m. The stress concentration factors for the key way for bending and torsion are 1.6 and 1.3 respectively. The notch sensitivity factor may be taken as 0.70 factor of safety is 1.5. Determine the diameter of the shaft. **(14 Marks)**

4 a. What are the advantages and disadvantages of threaded fastners? **(03 Marks)**

b. Obtain an expression for total load on a bolt in a bolted joint with gasket. **(05 Marks)**

c. A cylinder head is fastened to the cylinder of a compressor using 6 bolts of M20 size. Bolt material is C20 steel. The maximum pressure of the fluid is 3.5 MPa, cylinder dia is 75 mm. A soft gasket is used. Assuming initial tension required in each bolt is 70 kN, determine the factor of safety. Take $\sigma_{en} = 220$ MPa. **(12 Marks)**

PART – B

5 a. Explain advantages of hollow shafts over solid shafts. **(02 Marks)**

b. A power transmission shaft 1.3 m long is supported in bearings at its extreme ends A and B. A power of 30 kW is received at 500 rpm through a gear drive located at 400 mm to the right of the left extreme end of the shaft. PCD of the gear is 300 mm, pressure angle 20° and weighs 800 N. This gear receives power from a gear located exactly behind. When viewed from left the shaft is rotating in CCW direction. The power is delivered through a belt drive located 500 mm to the left of the right bearing. The pulley mounted on the shaft has a dia. of 400 mm and weighs 1 kN. The belt is directed towards the observer below the horizontal and inclined at 45°. Shaft is made of C40 steel. FOS is 2.5 and loading is with minor shock. Design the solid shaft. **(18 Marks)**

6 a. A mild steel shaft has to transmit 40 kW at 600 rpm. The maximum torque to be transmitted is 30% greater than the average torque. Design a rigid flanged coupling for this application. **(10 Marks)**

b. Design a knuckle joint to connect two mild steel rods. The joint has to transmit a tensile load of 80 kN. Allowable stresses for the material may be taken as $\sigma_t = 80$ MPa, $\sigma_{Cr} = 120$ MPa, $\tau = 40$ MPa. **(10 Marks)**

7 a. Design a diamond lap joint for a mild steel flat tie-bar $200\text{mm} \times 10\text{mm}$ using 24 mm dia rivets. Take rivet hole dia as equal to the dia of the rivet. Allowable stresses are: $\sigma_t = 120$ MPa, $\tau = 80$ MPa, $\sigma_C = 200$ MPa. **(10 Marks)**

b. Determine the size of the fillet weld required for the flat plate loaded as shown in Fig. Q7 (b). Allowable stress for the weld material is 60 MPa. **(10 Marks)**

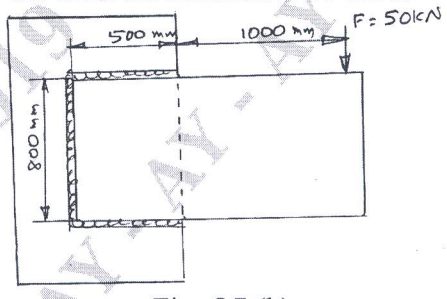

Fig. Q7 (b)

8 a. Derive an expression for torque required for raising the load in the case of a power screw. **(04 Marks)**

b. An automobile screw jack has to lift a load of 50 kN through a height of 150 mm. The screw is made of C30 steel. Nut is made of phosphor bronze for which allowable stresses may be : $\sigma_t = 30$ MPa, $\tau_{all} = 25$ MPa, $\sigma_{Cr} = 60$ MPa, bearing pressure = 14 MPa.

Design : (i) Screw (ii) Screw head and lever (iii) Nut.

Also check the screw for stresses induced. **(16 Marks)**

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