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Fifth Semester B.E. Degree Examination, July/August 2021 Design of Machine Elements

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions.

- 1 a. What are important properties of materials that are to be considered while selecting material? (08 Marks)
- b. Determine the safe load that can be carried by a bar of rectangular cross section of Fig.Q1 (b) shown below, limiting maximum stress to 130 MPa taking stress concentration into account. (08 Marks)

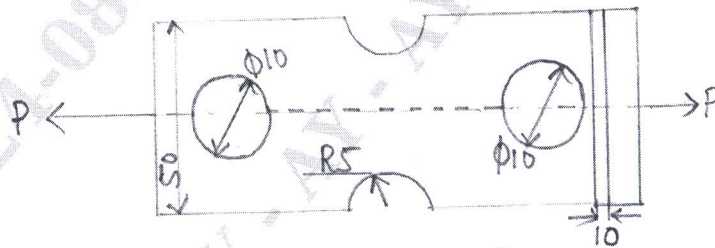


Fig. Q1 (b)

- 2 a. Explain following theories of failures :
 - (i) Rankine's theory.
 - (ii) Guest's theory.
 - (iii) Distortion energy theory. (06 Marks)
- b. A steel member is loaded as shown in Fig. Q2 (b) below. Determine the magnitude of
 - (i) Maximum normal stress
 - (ii) Minimum normal stress
 - (iii) Maximum shear stress. (10 Marks)

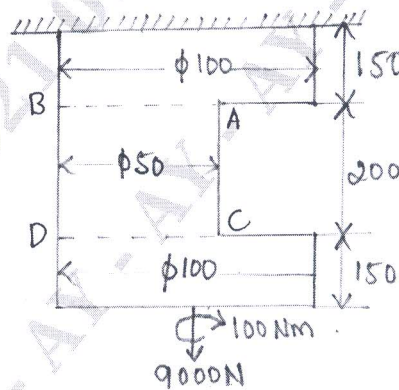


Fig. Q2 (b)

- 3 Design a flange coupling to connect the shaft of a motor and centrifugal pump for following specification, pump output = 3000 litres/minute, Total head = 20 m, Pump speed = 600 rpm, Pump efficiency = 70%. Select C40 steel ($\sigma_y = 328.6$ MPa) and for shaft C35 steel ($\sigma_y = 304$ MPa) for bolts with factor of safety 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm². (16 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 4 a. Explain stresses induced in power screw. (06 Marks)
 b. A single start square threaded power screw is used to raise a load of 120 kN. The screw has a mean diameter of 24 mm and four threads per 24 mm length. The mean collar diameter is 40 mm. The coefficient of friction is estimated as 0.1 for both the thread and the collar. Determine
 (i) Major diameter of the screw.
 (ii) Screw torque required to raise the load.
 (iii) Overall efficiency. (10 Marks)
- 5 A horizontal piece of commercial shafting is supported by two bearings 1.5 m apart. A keyed gear of 20° involute and 175 mm in diameter is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm 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 to 1, with the slack side on top. The drive transmits 45 kW at 330 rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflection in degrees. Use allowable shear stress 40 MPa and $G = 80 \times 10^9 \text{ N/mm}^2$. (16 Marks)
- 6 A shaft is supported by two bearings placed 1 m apart. A 500 mm diameter pulley is mounted at a distance of 200 mm to the right of the left hand bearing and this drives a pulley directly below it with the help of a belt having maximum tension of 3000 N. The pulley weighs 1000 N. Another pulley 300 mm diameter is placed 300 mm to the left of the right hand bearing and is driven with the help of an electric motor and the belt which is placed horizontally to the right when viewed from the left bearing. The pulley weighs 500 N. The angle of contact of both pulleys is 180° and $\mu = 0.24$. Determine suitable diameter for a solid shaft, assuming torque on one pulley is equal to torque on the other pulley. Choose C15 steel ($\sigma_y = 235.4 \text{ MPa}$, $\sigma_u = 425 \text{ MPa}$) as the shaft material and use ASME code for the design of shaft. Assume minor shock condition. (16 Marks)
- 7 Design a pair of spur gears to transmit a power of 18 kW from a shaft running at 1000 rpm to a parallel shaft to be run at 250 rpm maintaining a distance of 160 mm between the shaft centres. Suggest suitable surface hardness for the gear pair. (16 Marks)
- 8 Design a pair of helical gears to transmit power of 15 kW at 3200 rpm with speed reduction 4 : 1. The pinion is made of cast steel 0.4 % C untreated. The gear is made of high grade C1. Helix angle is limited to 26° and not less than 20 teeth are to be used on either gear. Suggest suitable surface hardness for the gear pair. (16 Marks)
- 9 a. Write down all the types of bearings using a block diagram. (04 Marks)
 b. Design the main bearing of a steam turbine that runs at 1800 rpm. The load on the bearings is estimated to be 2500 N. (12 Marks)
- 10 a. Explain stresses in a helical spring of circular wire. (04 Marks)
 b. Design a helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. Permissible shear stress of 420 MPa and modulus of rigidity of 84 kN/mm^2 . (12 Marks)

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