

Fifth Semester B.E. Degree Examination, Jan./Feb.2021
Design of Machine Elements – I

Time: 3 hrs.

Max. Marks:100

- Note:** 1. Answer FIVE full questions, selecting at least TWO questions from each part.
 2. Use of design data hand book is permitted.
 3. Assume missing data, if any.

PART – A

- 1 a. What are the factors to be considered for the selection of a material for a machine component? (04 Marks)
 b. What is mechanical engineering design? Explain. (04 Marks)
 c. A bracket with a rectangular cross section is shown in Fig. Q1 (c). The depth of cross section is twice the width. The force P acting on the bracket at 60° to vertical is 5 kN. The material of the bracket is grey cast-iron FG200 and the factor of safety is 3.5. Determine the dimensions of the cross section of the bracket.

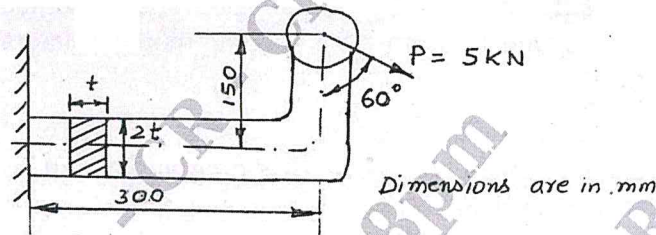


Fig. Q1 (c)

(12 Marks)

- 2 a. State and explain the following theories of failure: (i) Maximum normal stress theory (ii) Maximum shear stress theory. (06 Marks)
 b. Define stress concentration factor. Explain the methods used to reduce the stress concentration in a machine component. (06 Marks)
 c. A flat plate subjected to a tensile force of 5 kN is shown in Fig. Q2 (c). The plate material is Grey Cast Iron FG200 ($\sigma_{ut} = 200$ MPa) and factor of safety is 2.5. Determine the thickness of the plate.

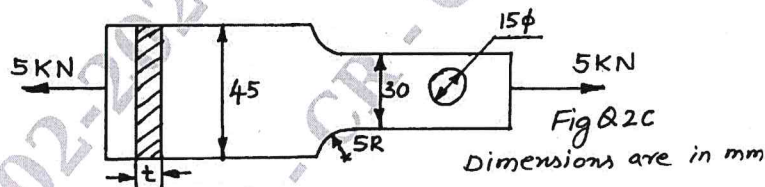


Fig. Q2 (c)

(08 Marks)

- 3 a. Sketch SN-diagram and indicate Low cycle fatigue, High cycle fatigue on it. (04 Marks)
 b. Define Endurance Limit. Name and explain any four factors which affect Endurance limit. (06 Marks)
 c. A stepped shaft with reduction ratio of 1.2 is to have a fillet radius of 10% of smaller diameter. The shaft is to be made of a material that has a notch sensitivity factor of 0.925, shear stress of 160 MPa at yield and shear stress of 120 MPa at endurance limit. Take surface correction factor of 0.90, size correction factor of 0.85 and factor of safety as 2.5. Determine the diameter of the stepped shaft to sustain a twisting moment that fluctuates between +800 Nm to -500 Nm.

(10 Marks)

- 4 a. Briefly explain the various types of stresses in threaded fasteners. (08 Marks)
- b. A structural connection shown in Fig. Q4 (b) is subjected to an eccentric force of 10 kN with an eccentricity of 500 mm. The centre distance between bolts 1 and 2 is 200 mm and the centre distance between bolts 1 and 3 is 150 mm. All the bolts are identical. The bolts are made of a material having yield strength in tension of 400 MPa. Take factor of safety as 2.5. Determine the size of the bolts. (12 Marks)

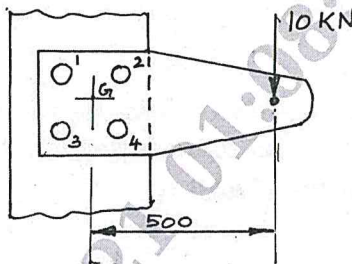


Fig. Q4 (b)

**PART - B**

- 5 A power transmission shaft 1500 mm long is supported by two bearings at A and D. A spur gear 20° involute and 175 mm diameter is keyed to the shaft at C 400 mm to the left of the right hand bearing and is driven by another spur gear directly behind it. A 600 mm diameter pulley is keyed to the shaft at B to the right of left hand bearing and drives a pulley with a horizontal belt directly behind it. The ratio of belt tensions is 3 : 1, with slack side on top. The drive transmits 45 kW at 330 rpm. The combined shock and fatigue factors for torsion and bending are 1.5. Draw the bending moment diagrams and determine the necessary shaft diameter. (20 Marks)
- 6 a. Name and explain any four types of keys. (04 Marks)
- b. Prove that a square key is equally strong in shear and compression. (04 Marks)
- c. Design a socket and spigot type cotter joint to carry an axial force of 100 kN. Use the following stresses : Allowable stress in tension and bending = 100 MPa ; Allowable stress in crushing = 150 MPa ; Allowable stress in shear = 60 MPa Sketch two views of joint showing major dimensions. (12 Marks)
- 7 a. Design a double riveted lap joint using 9 mm thick plates. The safe working stresses in tension, crushing and shear are 80 MPa, 120 MPa and 60 MPa respectively. Draw two views of the Joint. (10 Marks)
- b. Determine the size of weld required for an eccentrically loaded weld as shown in Fig. Q7 (b). The allowable stress in the weld is 95 MPa.

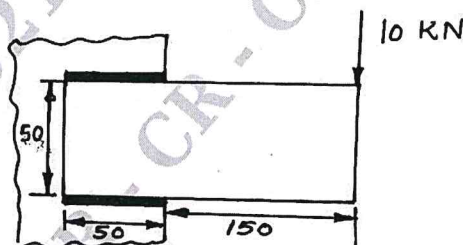


Fig. Q7 (b)

- 8 a. Explain self locking and over hauling in power screws. (05 Marks)
- b. A weight of 500 kN is raised at a speed of 6 m/min by two screw rods with square threads of 50×8 cut on them. The two screw rods are driven through bevel gear drives by a motor. Determine (i) Torque required to raise the load (ii) The speed of rotation of the screw rod assuming the threads are of double start (iii) Maximum stress induced on the cross section of the screw rod (iv) Efficiency of screw drive. (15 Marks)
