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06ME52

Fifth Semester B.E. Degree Examination, Dec.2015/Jan.2016
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 handbook is permitted.***

PART – A

1 a. Draw stress-strain diagram and explain all salient points for ductile and brittle materials. **(06 Marks)**

b. Define standardization. Write the standards used in machine design. **(06 Marks)**

c. A circular shaft 50 mm diameter fixed at one end is subjected to an axial load of 20 kN and a torque of 1.5 kN-m. If the length of the shaft is 300 mm, determine the nature and magnitude of stresses at the critical point. **(08 Marks)**

2 a. Explain the following theories of failure:
i) Maximum normal stress theory
ii) Maximum shear stress theory
iii) Distortion energy theory **(06 Marks)**

b. A section of 50 mm diameter shaft has a transverse hole of 2.5 mm dia. Bending moment acting at this section is 1.5 kN.m. Determine:
i) Nominal stress in shaft at this section
ii) Stress concentration factor and maximum stress
iii) Factor of safety, if the material is hot rolled steel with yield stress of 350 MPa. **(06 Marks)**

c. Determine the cross section dimension for the cantilever of length 200 mm, when it is subjected to an impact by a weight of 1000 N falling through 1 mm height at the free end. Take depth of section as 4 times the width and allowable stress of 80 MPa. **(08 Marks)**

3 a. With a neat diagram, explain a S.N. curves and define (i) Notch sensitivity, (ii) Fatigue stress concentration factor. **(08 Marks)**

b. A plate shown in Fig.Q3(b) is subjected to a fluctuating load which varies from 19600 N to 9800 N. Determine whether it is safe to operate the plate continuously. Given that σ_u = 274 MPa, σ_{end} = 235 MPa. Load, size and surface correction factors are 0.7, 0.5 and 0.8 respectively.

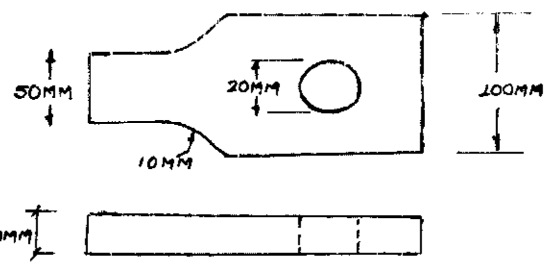

Fig.Q3(b) **(12 Marks)**

4 a. A cylinder head of a steam engine is subjected to a steam pressure of 0.7 N/mm^2. It is held in position by means of 12 bolts. A soft copper gasket is used to make the joint leak proof. The effective diameter of the cylinder is 300 mm. Find the size of the bolt so that the stress in the bolt is not to exceed 100 MPa. **(10 Marks)**

b. A flanged bearing is shown in Fig.Q4(b) is fastened to a frame by five bolts spaces equally on bolt circle of 300 mm diameter. The diameter of the flange is 400 mm load is 40 kN. Taking the safe tensile stress for bolt material as 60 MPa. Determine the size of the bolts. **(10 Marks)**

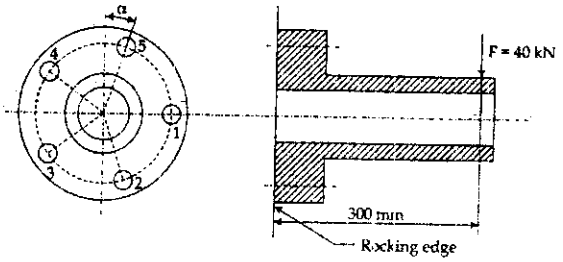

Fig.Q4(b)

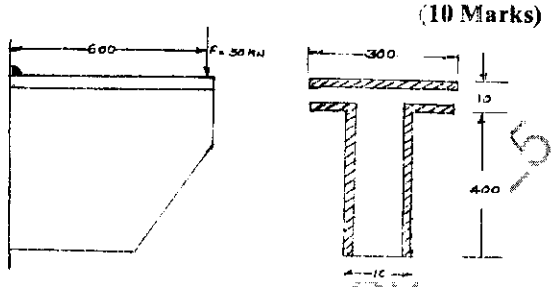

Fig.Q7(a)

PART – B

5 A hoisting drum 0.5 m in diameter is keyed to a shaft which is supported in two bearings and driven through a 12:1 reduction ratio by an electric motor. Determine the power of the driving motor, if the maximum load of 8 kN is hoisted at a speed of 50 m/min and the efficiency of the drive is 80%. Also determine the torque on the drum shaft and the speed of the motor in rpm. Determine also the diameter of the shaft made of machinery steel, the working stresses of which are 115 MPa in tension and 50 MPa in shear. The drive gear whose dia is 450 mm is mounted at the end of the shaft, such that it overhangs the nearest bearing by 150 mm. The combined shock and fatigue factors for bending and torsion may be taken as 2 and 1.5 respectively. **(20 Marks)**

6 a. Show that the length of the square key is approximately equal to 1.5d, where d = dia of shaft for equal torsional strength of shaft and key. **(04 Marks)**

b. A 50 mm diameter steel shaft made of C45 steel transmits maximum power in tension. A key sometimes used as a shear pin for economical reasons in case of extreme overloads. A (6 × 6) mm square key made of C-30 steel is to be used. Determine the length of the key it is to have 60% of the maximum strength capacity of the shaft. Assume f.o.s = 3 (shaft), 2 for key. **(06 Marks)**

c. Design a knuckle joint to connect two mild steel rods subjected to an axial pull of 100 kN. The allowable stresses for rods and pin are 100 MPa, 130 MPa and 60 MPa in tension, crushing and shear respectively. The bending of the pin is prevented by selection of proper fit. **(10 Marks)**

7 a. An electronic connection is shown in Fig.Q7(a). Determine the size of weld, if maximum shear stress in weld is not to exceed 75 MPa. **(10 Marks)**

b. Design a triple riveted zigzag lap joint to connect two plates each 12 mm thick. Draw neat sketch of the joint, by considering structural joint with σ_t = 115 MPa, τ = 70 MPa and σ_c = 140 MPa. **(10 Marks)**

8 Design a screw jack for a load capacity of 50 kN, lifting height of 500 mm. The material of screw may be taken as C-25 steel. Take factor of safety 2.25 for screw and 2 for nut. Nut is made of phosphor bronze. By considering the following:

i) Increase the minor dia by 25% on account of buckling and tension.
ii) Bearing stress P_b = 14.7 MPa.
iii) Increase the number of threads by thread for stability.
iv) Assume friction at collar = f_c = 0.2.
v) Major dia of collar = 1.5 mean dia, minor dia of collar = 0.5 mean dia.
vi) Force at the end of the handle is 350 N.
vii) Increase the length of the handle by 75 to 80 mm for gripping purpose. **(20 Marks)**

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