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06ME52/06AU52

Fifth Semester B.E. Degree Examination, June 2012
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 machine design data hand book is permitted.***

PART – A

1 a. Identify the following engineering materials giving specifications:
i) FG350 ii) FeE300 iii) C35Mn75 iv) X20Cr18Ni2 **(04 Marks)**

b. A point in a structural member is subjected to plane state of stress as shown in Fig. Q1 (b). Determine the following :
i) Normal and tangential stress intensities at an angle of $\theta = 45°$.
ii) Principal stresses σ_1 and σ_2 and their directions.
iii) Maximum shear stress and its plane. **(10 Marks)**

c. Determine the required thickness 'b' of the steel bracket at section A – A, when loaded as shown in Fig. Q1 (c) in order to limit the maximum tensile stress to 70 MPa. **(06 Marks)**

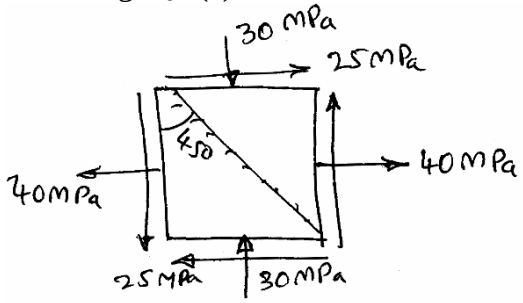


Fig. Q1 (b)

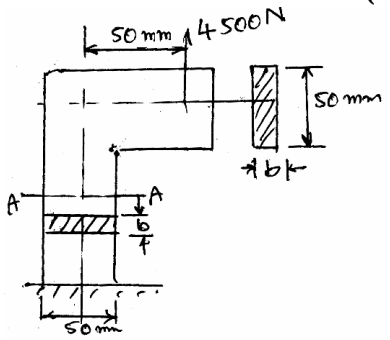


Fig. Q1 (c)

2 a. Explain the following theories of failure and state when they are used:
i) Maximum principal stress theory.
ii) Maximum shear stress theory. **(05 Marks)**

b. A round stepped shaft is made of brittle material cast iron FG 260 and subjected to a bending moment of 15 N-m as shown in Fig. Q2 (b). The stress concentration factor at the fillet is 1.5. Determine the following : i) step diameter ii) magnitude of stress at fillet iii) factor of safety. **(10 Marks)**

c. Derive an expression for impact stress in a axial bar of cross section 'A' and length 'L' due to the impact of a load 'W' falling from a height 'h' on the bar, as shown in Fig. Q2 (c). **(05 Marks)**

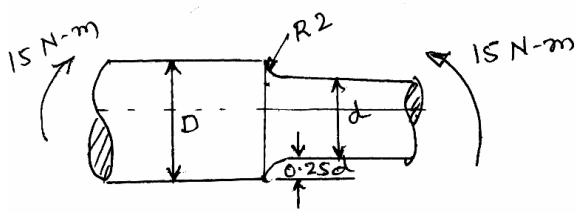


Fig. Q2 (b)

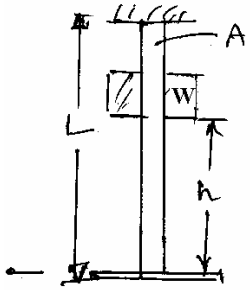
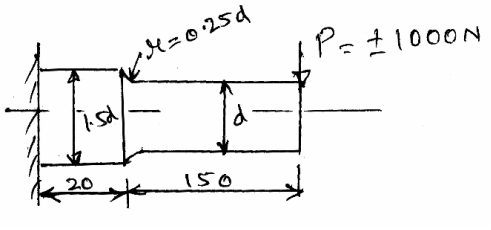
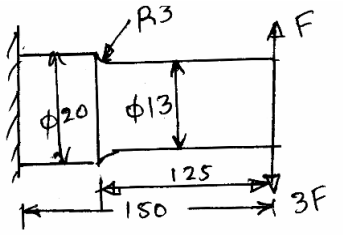


Fig. Q2 (c)

3 a. A Cantilever beam made of 35C8 steel (σ_{ut} = 540 MPa) is subjected to a completely reversed load of 1000 N as shown in Fig. Q3 (a). The notch sensitivity factor 'q' at the fillet can be taken as 0.85 and expected reliability is 90%. Determine the diameter of the beam for a life cycle of 10000 cycles. **(10 Marks)**



All dimensions in mm
Fig. Q3 (a)

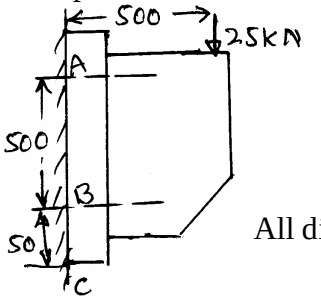


All dimensions in mm
Fig. Q3 (b)

b. A cantilever beam made of cold drawn C30 steel (σ_{ut} = 550 MPa and σ_{yt} = 470 MPa) subjected to a load which varies from –F and 3F, as shown in Fig. Q3 (b). Determine the maximum load that this member can withstand for an indefinite life using a factor of safety '2'. The stress concentration factor effect has to be considered with notch sensitivity of 0.9. Analyse at the fillet section only. **(10 Marks)**

4 a. Write a note on bolts of uniform strength. **(06 Marks)**

b. A wall bracket is attached to a wall by means of 4 identical bolts, two at A and two at B, as shown in Fig. Q4 (b). Assuming that the bracket is held against the wall and prevented from tipping about C, by all four bolts, and using an allowable stress in the bolts as 35 MPa, determine the size of bolts on the basis of maximum principal stress theory, selecting ISO, metric threads of not more than 1.5 mm pitch. **(14 Marks)**



All dimensions in mm
Fig. Q4 (b)

PART – B

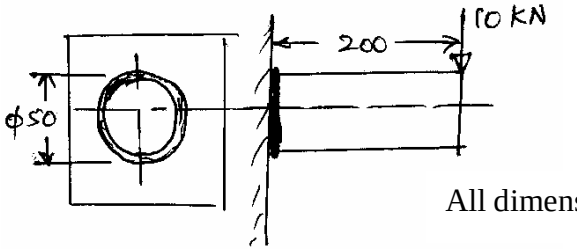
5 A transmission shaft running at 500 rev/min is supported on bearings 800 mm apart. Twenty K.W power is supplied to the shaft through a 450 mm dia pulley which is located 400 mm to the right of right bearing and receives power from a motor placed directly below the shaft. The shaft further transmits this power to a spur gear of 300 mm pitch circle diameter, which is located at 400 mm to the right of left bearing. The gear has 20° involute teeth and ratio of belt tensions is 3:1. The gear drives another gear which is placed directly above the shaft. The gear and pulley are keyed to the shaft. Selecting the material as steel having σ_{ut} = 700 MPa and σ_{yt} = 460 MPa as per ASME code, determine the diameter of shaft. Assume shock factors for bending and torsion as 1.5. **(20 Marks)**

6 a. The standard cross-section of a flat key, which is fitted on a 50 mm diameter shaft is 16×10 mm. The key is transmitting 475 N-m torque from the shaft to the hub. The key is made of commercial steel for which yield strength in both tension and compression may be taken as 230 N/mm^2. Determine the minimum length of key required if the factor of safety is 3. **(06 Marks)**

6 b. It is required to design a rigid type flange coupling to connect two shafts. The input shaft transmits 37.5 KW at 180 rev/min to the output shaft through the coupling. The starting torque is 50% higher then the rated torque. Select material for flanges as cast iron FG200 (σ_{ut} = 200 MPa) with a factor of safety 6, material for shafts as carbon steel with σ_{yt} = 380 MPa, with a factor of safety 2.5, material for key and bolts may be taken as steel with σ_{yt} = 400 MPa (in tension) and σ_{yc} = 600 MPa (in compression) respectively and a factor of safety 2.5. Design the coupling and give major dimensions. **(14 Marks)**

7 a. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.9 MPa. Assume joint efficiency as 75%. Allowable stress in tension for the plate is 83 MPa in compression 138 MPa and shear stress in rivets may be assumed as 55 MPa. Assume chain riveted joint. **(10 Marks)**

b. A circular shaft 50 mm in diameter is welded to a support by means of a fillet weld and loaded as shown in Fig. Q7 (b). Determine the size of weld if the permissible shear stress in the weld is limited to 100 MPa. **(10 Marks)**



All dimensions in mm

Fig. Q7 (b)

8 a. Derive an expression for the maximum efficiency of a square threaded screw and thus show that for self locking screw the efficiency is always less than 50%. **(06 Marks)**

b. The lead screw of a lathe has single start ISO metric trapezoidal threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2 kN in order to drive the tool carriage during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of co-efficient of friction at the screw threads and collar are 0.15 and 0.12 respectively. The lead screw rotates at 30 rev/min. Calculate :

i) The power required to drive the screw.

ii) The efficiency of the screw. **(14 Marks)**

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