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10ME52

Fifth Semester B.E. Degree Examination, June/July 2014
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 the stress-strain diagrams for a ductile material and a brittle material and show the salient points on them. **(05 Marks)**

b. For the stress-element shown in Fig.Q1(b), find the principal stresses and directions. **(06 Marks)**

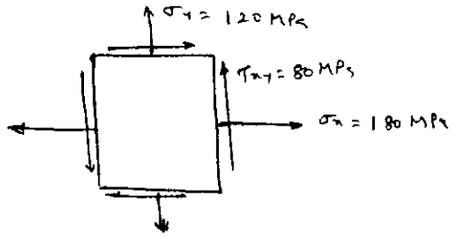


Fig.Q1(b)

c. Determine the maximum normal stress and shear stress for the figure shown in Fig.Q1(c). **(09 Marks)**

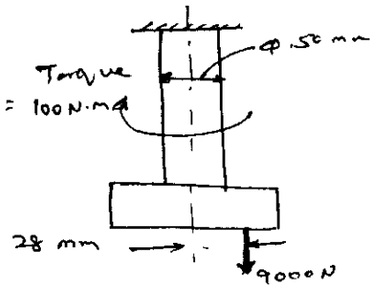


Fig.Q1(c)

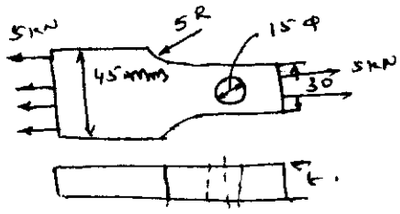


Fig.Q2(b)

2 a. Explain the following theories of failure:
(i) Maximum shear stress theory (ii) Distortion energy theory. **(05 Marks)**

b. A flat plate subjected to a tensile force of 5 kN is shown in Fig.Q2(b). The plate material is grey cast iron having $\sigma_{ultimate}$ = 200 MPa. Determine the thickness of the plate. Factor of safety is 2.5. **(08 Marks)**

c. A weight 600 N drops through a height of 20 mm and impacts the center of 300 mm long simply supported circular cross section beam. Find the diameter of the beam and the maximum deflection, if the allowable stress is limited to 90 MPa. Neglect the inertia effect and take E = 200 GPa. **(07 Marks)**

3 a. Derive Soderberg's equation for ductile material. **(05 Marks)**

b. A hot rolled steel rod is subjected to a torsional load that varies from +330 N-m clockwise to 110 N-m counter clockwise and an applied bending moment varies from +440 N-m to – 220 N-m The rod is of uniform cross-section. Determine the required rod diameter. The material has an ultimate tensile strength of 550 MPa and a yield strength of 410 MPa. Design based on a factor of safety of 1.5. Take the endurance limit as half the ultimate strength. **(15 Marks)**

4 a. Explain the stresses induced in a screw fastening subjected to static, dynamic and impact loading. **(12 Marks)**

b. A bolt is subjected to initial loading of 5 kN and final tensile load of 9 kN. Determine the size of the bolt, if the allowable stress is 80 MPa and K = 0.05. **(08 Marks)**

PART – B

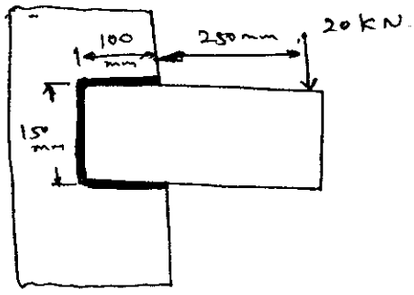
5 A horizontal steel shaft, supported on bearings "A" at the left end and "B" at the right end, carries two gears "C" & "D", located at distances 250 mm and 400 mm respectively, from the center lines of left and right end bearings. The pitch diameter of gear C is 600 mm and that of gear D is 200 mm. The pressure angle is 20°. The distance between the center lines of the bearings is 2400 mm. The shaft transmits 20 kW power at 120 rpm. The power is delivered to the shaft at gear C and is taken out at gear D in such a manner that the tooth pressure F_{+C} and F_{+D} of gears C and D act vertically downwards. Find the diameter of the shaft, if the working stresses are100 MPa in tension and 56 MPa in shear. The gear C and D weigh 950 N and 350 N respectively. Take $C_m = 1.5$ and $C_T = 1.2$. **(20 Marks)**

6 a. Design a cotter joint to sustain an axial load of 100 kN. Allowable stress in tension 80 MPa. Allowable stress in compression 120 MPa. Allowable shear stress 60 MPa. Allowable bearing pressure 40 MPa. **(10 Marks)**

b. Design a flanged coupling to connect the shafts of motor and pump transmitting 15 kW power at 600 rpm. Select C40 steel for shaft and C_{35} steel for bolts, with factor of safety = 2. Use allowable shear stress for Cast-Iron flanges = 15 N/mm^2; $\sigma_{allowable}$ = 162 N/mm^2 ; and $\tau_{allowable}$ = 81 N/mm^2 for bolts σ = 152 N/mm^2 and τ = 76 N/mm^2. **(10 Marks)**

7 a. Design a double riveted lap joint with chain rivetting for a mild steel plates of 20 mm thick taking the allowable values of stress in shear, tension and compression to 60, 90 and 120 MPa respectively. **(10 Marks)**

b. Determine the size of the weld for a welded joint loaded, if the permissible shear stress for the weld material is 75 MPa. **(10 Marks)**



8 a. Explain self locking and overhauling in power screws. **(05 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.

(i) Determine the major diameter of the screw.
(ii) Estimate the screw torque required to raise the load.
(iii) Estimate overall efficiency.
(iv) If collar friction is eliminated, what minimum value of thread coefficient is needed to prevent the screw from overhauling? **(15 Marks)**

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