

USN

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Fifth Semester B.E. Degree Examination, July/August 2021

Design of Machine Elements – I

Time: 3 hrs.

Max. Marks: 80

**Note: 1. Answer any FIVE full questions.
2. Use of design data hand book is permitted.**

- 1 a. Explain briefly the following :
 - i) Failure of ductile materials
 - ii) Failure of brittle materials

(06 Marks)
- b. Determine the maximum normal and maximum shear stress at section A-A for the crank shown in Fig Q1(b), when a load of 10kN, assumed concentrated is applied at the centre of the crank pin-Neglect the effect of transverse shear.

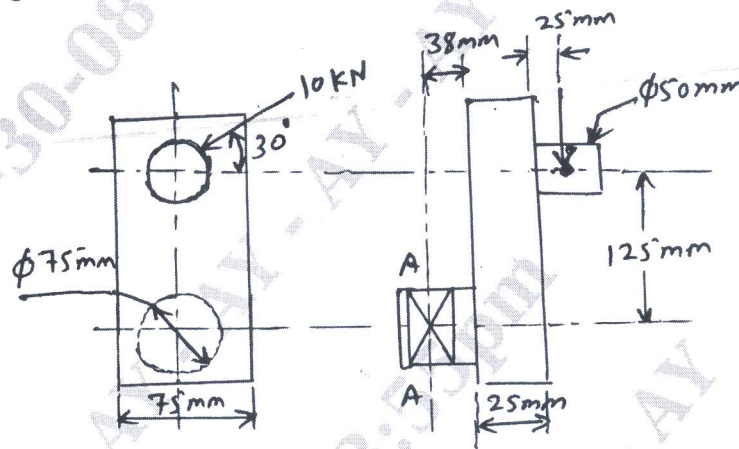


Fig Q1(b)

(10 Marks)

- 2 a. Explain the following theories of failure :
 - i) Maximum principal stress theory
 - ii) Maximum shear stress theory
 - iii) Distortion energy theory.

(06 Marks)
- b. A plate of C-45 steel ($\sigma_y = 353\text{MPa}$) is subjected to the following stresses, $\sigma_x = 150\text{N/mm}^2$, $\sigma_y = 100\text{N/mm}^2$ and $\tau_{xy} = 50\text{N/mm}^2$, find the factor of safety by
 - i) Maximum principal stress theory
 - ii) Maximum shear stress theory
 - iii) Hencky Mises theory.

(10 Marks)
- 3 a. A shaft of 50mm diameter is stepped down to 40mm with a fillet radius of 5mm. If the allowable shear stress is 50N/mm^2 , determine the power that can be transmitted at 1200rpm. (shaft subjected to twisting moment).

(10 Marks)
- b. Derive an expression for instantaneous stress due to axial impact.

(06 Marks)
- 4 a. Explain briefly the following factors effecting endurance limit.
 - i) Type of load
 - ii) Surface condition and corrosion
 - iii) Size of section.

(06 Marks)
- b. A piston rod is subjected to a maximum reversed axial load of 110kN. It is made of steel having an ultimate stress of 900N/mm^2 and the surface is machined. The average endurance limit is 50% of the ultimate strength. Take the size correction coefficient as 0.85 and FOS = 1.75. Determine the diameter of the rod.

(10 Marks)

- 5 a. A rectangular sunk key 14mm wide \times 10mm thick \times 75mm long is required to transmit 1200N-m torque from a 50mm diameter solid shaft. Determine whether the length is sufficient or not if the allowable shear stress and crushing stress are limited to 56MPa and 168MPa respectively. (06 Marks)
- b. Design and sketch the assembly of a knuckle joint to connect two mild steel rod subjected to an axial pull of 100kN. The allowable stresses for rods and pin are 100MPa, 130MPa and 60MPa in tension crushing and shear respectively. The bending of the pin is prevented by selection of proper fit. (10 Marks)
- 6 a. Explain briefly the design for strength and rigidity with steady load. (06 Marks)
- b. A shaft is mounted between bearing located 9.5m apart and transmits 10,000kW at 90rpm. The shaft weighs 66,000N, has outside diameter = 450mm and inner diameter = 300mm. Determine the stress induced in the shaft and the angular deflection between the bearings. Do not neglect the weight of shaft. (10 Marks)
- 7 Design a triple riveted butt joint to join two plates of thickness 10mm. The pitch of rivets in the extreme rows, which are in single shear is twice the pitch of rivets in the inner rows which are double shear. The design stresses of the materials of the main plates and the rivets are as follows : $\sigma_t = 120\text{MPa}$ (plate), $\sigma_c = 160\text{MPa}$ (rivet), $\tau = 80\text{MPa}$ (rivet). Draw neat sketches of the joint in two views. (16 Marks)
- 8 a. A plate of 50mm wide and 10mm thick is to be welded to another plate by means of transverse fillet weld at the ends. If the allowable tensile stress is 100N/mm^2 , determine the length of weld. (06 Marks)
- b. A 16mm thick plate is welded to a vertical support by two fillet welds as shown in Fig Q8(b). Determine the size of weld, if the permissible shear stress for the weld material is 75MPa.

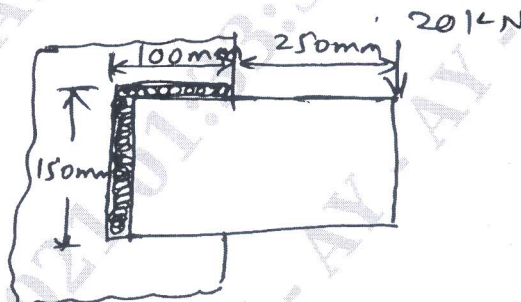


Fig Q8(b)

(10 Marks)

- 9 a. Explain briefly stresses in screw fastening due to static loading. (08 Marks)
- b. A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300mm. The vessel carries a fluid at a pressure of 0.7N/mm^2 . A copper asbestos gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate on to the pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100N/mm^2 . (08 Marks)
- 10 a. Explain self locking and overhauling in power screws. (04 Marks)
- b. Derive an expression for torque required to raise the load on square threaded screw. (06 Marks)
- c. Show that efficiency of self locking screw is less than fifty percentages. (06 Marks)
