



Fifth Semester B.E. Degree Examination, December 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 design data hand book is permitted.

PART – A

- 1 a. Draw the stress-strain curve for mild steel and cast iron. Name the salient points. (06 Marks)
b. What are the important mechanical properties of metals? Explain each of them briefly. (10 Marks)
c. What is standardization? What are advantages of standardization? (04 Marks)
- 2 a. The stresses induced at a critical point in a machine component made of steel 45C8 with yield strength (σ_{yt}) of 380 MPa are as follows: $\sigma_x = 100$ MPa, $\sigma_y = 40$ MPa, $\tau_{xy} = 80$ MPa. Calculate factor of safety by:
i) the maximum normal stress theory.
ii) the maximum shear stress theory.
iii) the distortion energy theory. (10 Marks)
b. An unknown weight falls through 15 mm on a collar rigidly attached to the lower end of a vertical bar 3 m long and 500 mm² in section. If the maximum instantaneous extension is known to be 2 mm, what is the corresponding stress and the value of unknown weight. Take $E = 200$ kN/mm². (10 Marks)
- 3 a. Define endurance limit. State and explain the factors for modifying it. (06 Marks)
b. The work cycle of a mechanical component subjected to completely reversed bending stresses consists of the following three elements:
i) ± 350 MPa for 85% of time. ii) ± 400 MPa for 12% of time.
iii) ± 500 MPa for 3% of time.
The material for the component is 50C4 ($\sigma_u = 660$ N/mm²) and the corrected endurance strength of the component is 280 MPa. Determine the life of the component. (14 Marks)
- 4 a. A cover plate is bolted on to the flanged end of a pressure vessel through 6 bolts. The inner diameter of the pressure vessel is 200 mm and is subject to an internal pressure of 10 MPa. Selecting carbon steel C40 with $\sigma_y = 328.6$ MPa as the material for the bolts determine the size of the bolts, considering initial tension for the following cases:
i) Metal to metal joints,
ii) A copper gasket. (10 Marks)
b. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig. Q4 (a). Calculate the size of the bolts if the load is 10 kN and allowable shear stress in the bolt material is 40 MPa. (10 Marks)

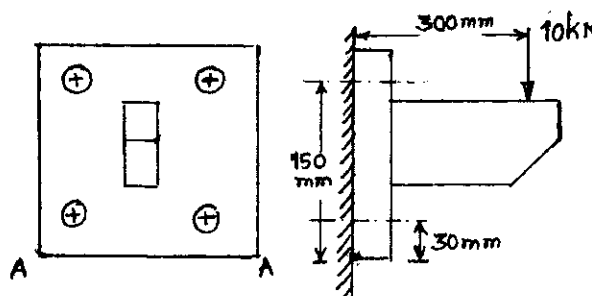


Fig. Q4 (b)
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PART – B

- 5 a. Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 200 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 120 rpm. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2.0 respectively. The allowable shear stress in the shaft may be taken as 35 MPa. (10 Marks)
- b. A solid shaft of diameter d is used in power transmission. Due to modification of existing transmission system, it is required to replace the solid shaft by a hollow shaft of the same material and equally strong in torsion. Further, the weight of hollow shaft per meter length should be half of the solid shaft. Determine the outer diameter of hollow shaft in terms of d . (10 Marks)
- 6 a. Design a socket and spigot type cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses: $\sigma_t = 100$ MPa, $\sigma_c = 150$ N/mm² and $\tau = 60$ MPa. (10 Marks)
- b. A rectangular sunk key 14 mm wide \times 10 mm thick \times 75 mm long is required to transmit 1200 N-m torque from a 50 mm diameter solid shaft. Determine whether the length is sufficient or not if the permissible shear stress and crushing stress are limited to 56 MPa and 168 MPa respectively. (06 Marks)
- c. What is coupling? What are the requirements of a good coupling? (04 Marks)
- 7 a. Explain in detail the various possible modes of failure of a riveted 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 75 MPa. (10 Marks)

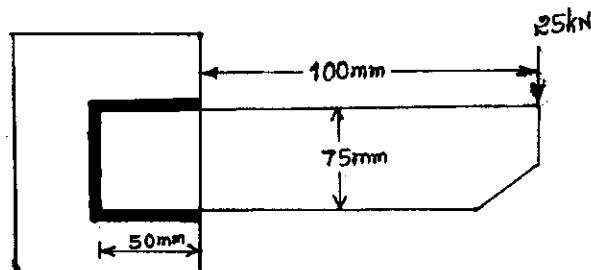


Fig. Q7 (b)

- 8 a. What is self-locking of power screw? What is the condition for self-locking? State the applications where self-locking is essential. (05 Marks)
- b. A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double threads. The load on the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. The coefficient of friction for the screw is 0.1 and the collar is 0.09. Determine :
- Torque required to raise the screw against load.
 - Torque required to lower the screw with the load.
 - Overall efficiency.
 - Is this screw self-locking?
- (15 Marks)

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