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06ME52

Fifth Semester B.E. Degree Examination, June/July 2011
Design of Machine Elements – I

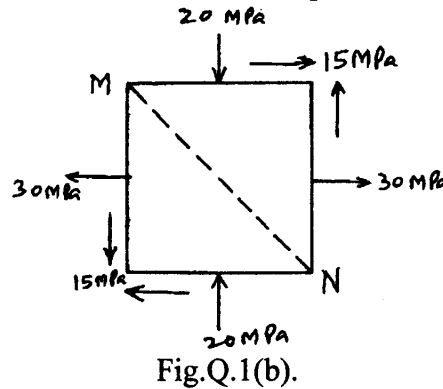
Time: 3 hrs.

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 stress – strain diagram for mild steel subjected to tension. Explain the significance of salient points. (06 Marks)
- b. A point in a structural member subjected to plane stress is shown in Fig.Q.1(b). Determine the following :
 - i) Normal and tangential stress intensities on plane MN inclined at 45°.
 - ii) Principal stresses and their direction.
 - iii) Maximum shear stress and the direction of the planes on which it occurs. (14 Marks)



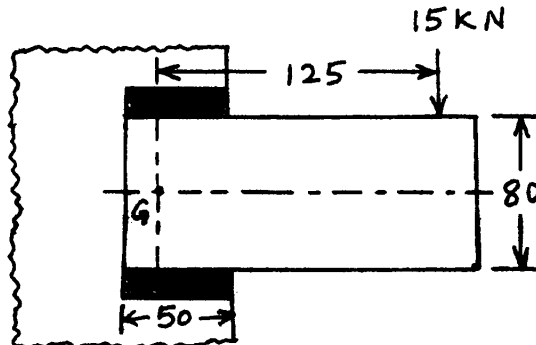
- 2 a. Explain the following theories of failure :
 - i) Maximum normal stress theory.
 - ii) Maximum distortion energy theory. (08 Marks)
- b. An unknown weight falls through 10 mm on a collar rigidly attached to the lower end of a vertical bar 3000 mm long and 600 mm² in section. If the maximum 2mm. What is the corresponding stress and the value of unknown weight? Take E = 200 kN/mm². (12 Marks)
- 3 a. Derive Goodman's equation. (04 Marks)
- b. Explain cumulative fatigue damage. (04 Marks)
- c. A circular bar of 500 mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic upon load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of bar by taking a factor of safety of 2, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by : ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa. (12 Marks)
- 4 a. The cylinder head of a steam engine is subjected to a steam pressure of 0.7 N/mm². 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 cylinder is 300 mm. Find the size of the bolts so that the stress in the bolts is not to exceed 100 N/mm². (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

- b. Estimate the maximum wrench torque which can be applied in tightening a 20 mm bolt if the shear stress in the body of the bolt is not to exceed 140 MN/m^2 . Outside bolt diameter = 20 mm, root diameter = 16.72 mm, thread section has 60° included angle ($\theta = 30^\circ$), pitch = 2.5 mm, effective friction radius under nut, $r_c = 12 \text{ mm}$, thread and collar friction coefficient estimated at 0.10. (10 Marks)

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 r.p.m. 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 diameter 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. Design a Knuckle joint to transmit 150 kN. The design stresses may be taken as 75 N/mm^2 in tension, 60 N/mm^2 in shear and 150 N/mm^2 in compression. (10 Marks)
- b. A splined connection in an automobile transmission consists of 10 splines cut in a 58 mm diameter shaft. The height of each spline is 5.5 mm and the keyways in the hub are 45 mm long. Determine the power that may be transmitted at 2500 rev/min if the allowable normal pressure on the splines is limited to 4.8 MPa. (10 Marks)
- 7 a. Design a double riveted lap joint with zig – zag riveting for 13 mm thick plates. The working stresses to be used are $\sigma_t = 80 \text{ MPa}$; $\tau = 60 \text{ MPa}$; $\sigma_c = 120 \text{ MPa}$. State how the joint will fail and find the efficiency of the joint. (10 Marks)
- b. A bracket carrying a load of 15 kN is to be welded as shown in Fig.Q.7(b). Find the size of the weld required if the allowable shear stress is not to exceed 80 MPa. (10 Marks)



All dimensions in mm.

Fig.Q.7(b).

- 8 a. Derive the equation for maximum efficiency of a square threaded screw. (08 Marks)
- b. The cutter of a broaching machine is pulled by square threaded screw of 55 mm external diameter and 10 mm pitch. The operating nut takes the axial load of 400 N on a flat surface of 60 mm and 90 mm internal and external diameters respectively. If the coefficient of friction is 0.15 for all contact surfaces, determine the power required to rotate the nut when the cutting speed is 6m/min. Also find the efficiency of the screw. (12 Marks)

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