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17ME54

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022

Design of Machine Elements – I

Time: 3 hrs.

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Design Handbook is permitted.

Module-1

- 1 a. State and explain maximum shear stress theory of failure. (06 Marks)
- b. Determine the required thickness of the steel bracket at section A-A, when loaded as shown in Fig.Q1(b) in order to limit the tensile stress to 100 N/mm^2 . All dimensions are in mm.

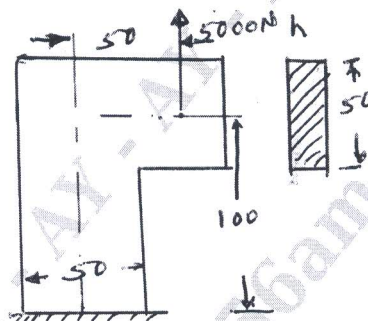


Fig.Q1(b)

(08 Marks)

- c. Discuss the factors influencing the selection of a suitable material for machine elements. (06 Marks)

OR

- 2 a. What are the important mechanical properties of metals? Explain each of them briefly. (06 Marks)
- b. An off-set link subjected to a force of 25 kN is shown in Fig.Q2(b). It is made grey Cast Iron, FG300 and factor of safety is 3. Determine the dimension of cross section of the link.

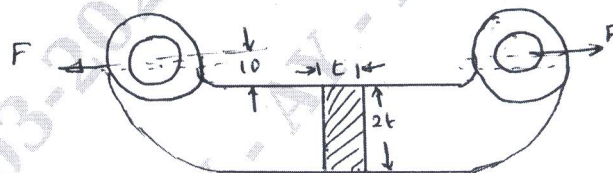


Fig.Q2(b)

(07 Marks)

- c. A flat plate subjected to a tensile force of 5 kN is shown in Fig.Q2(c). The plate material is grey Cast Iron FG200 and the factor of safety is 2.5. Determine the thickness of the plate. $\sigma_{ut} = 200 \text{ N/mm}^2$

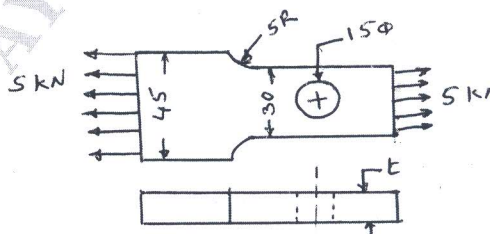


Fig.Q2(c)

(07 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.

Module-2

- 3 a. Derive an expression for stress induced in a rod due to the axial impact of weight 'w' dropped from a height 'h' on to a collar attached at the free end of the rod. (06 Marks)
- b. A weight of 500 N drops through 25 mm at the center of a 250 mm long simply supported beam. The beam has a rectangular cross-section. It is made of steel with $\sigma_y = 300 \text{ N/mm}^2$ and factor of safety is 2. The modulus of elasticity is $207 \times 10^3 \text{ N/mm}^2$. Determine the dimension of the cross section of the beam, if the depth is twice that of the breadth. (07 Marks)
- c. A steel rod is 1500 mm long. It has to resist longitudinally an impact of 2500 N falling under gravity a velocity of 0.99 m/s. Maximum computed stress is limited to 150 N/mm^2 . Determine diameter of the rod required. (07 Marks)

OR

- 4 a. Derive the Soderberg equation with usual notation. (04 Marks)
- b. A solid circular shaft made of steel with $\sigma_{ut} = 620 \text{ N/mm}^2$ and $\sigma_y = 380 \text{ N/mm}^2$ is subjected to an alternating bending moment, which varies for -200 N-m to $+400 \text{ N-m}$. Neglecting stress concentration, calculate the shaft diameter for infinite life using Soderberg's theory. (08 Marks)
- c. A rod of a linkage mechanism made of steel with $\sigma_{ut} = 550 \text{ N/mm}^2$ is subjected to a completely reversed axial load of 100 kN. The rod is machine on a lathe. There is no stress concentration. Determine the diameter of the rod using a factor of safety of 2 for an infinite life condition. (08 Marks)

Module-3

- 5 a. A flat key 14 mm wide, 14 mm thick and 75 mm long is required to transmit 1200 Nm 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 N/mm^2 and 168 N/mm^2 , respectively. (05 Marks)
- b. A solid steel shaft running at 600 rpm is supported on bearings 1000 mm apart. The shaft receives 40 KW through a 40 mm diameter pulley weighing 400 N located 300 mm to the right of left bearing by a vertical flat belt drive. The power is transmitted from the shaft through another pulley of diameter 600 mm weighing 600 N located 200 mm to the left of right bearing. The belt drives are at right angles to each other and ratio of belt tension is 3.0. Design the shaft if the allowable shear stress in the shaft material is 40 N/mm^2 . Take $K_m = 1.2$, $K_t = 1.1$. (15 Marks)

OR

- 6 a. Design a solid flange coupling of a marine type to transmit 8.4 KW at 400 rpm. The allowable shear stress for the shaft and both may be taken as 60 N/mm^2 and allowable crushing stress for key may be taken as 110 N/mm^2 . (10 Marks)
- b. Design a Cotter Joint to connect two round rods and to sustain an axial load of 120 kN. The allowable stresses are 100 N/mm^2 in tension, 70 N/mm^2 in shear and 150 N/mm^2 in crushing. (10 Marks)

Module-4

- 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 1 N/mm^2 . Assume an efficiency of 75%, allowable stress in plate and rivets as 90 N/mm^2 (tension), 140 N/mm^2 (crushing) and 56 N/mm^2 (shear). (10 Marks)