CBCS SCHEME

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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.

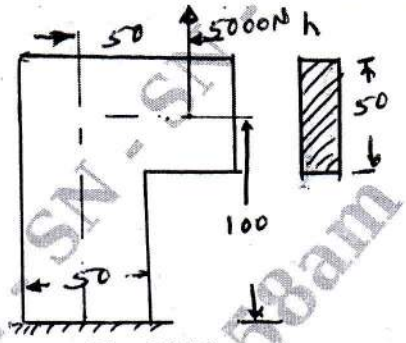

Fig.Q1(b) **(08 Marks)**

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.

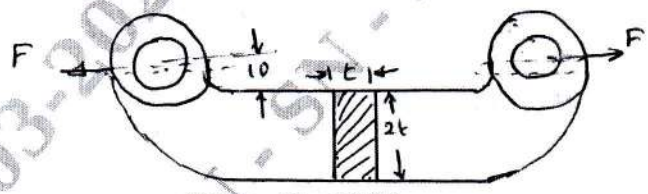

Fig.Q2(b) **(07 Marks)**

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. σ_{ut} = 200 N/mm^2

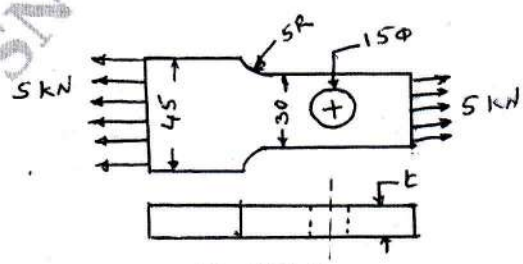

Fig.Q2(c) **(07 Marks)**

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 $\sigma_y = 300$ N/mm^2 and factor of safety is 2. The modulus of elasticity is 207×10^3 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 $\sigma_{ut} = 620$ N/mm^2 and $\sigma_y = 380$ N/mm^2 is subjected to an alternating bending moment, which varies for –200 N-m to +400 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 $\sigma_{ut} = 550$ 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 intension, 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)**

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 N/mm^2.

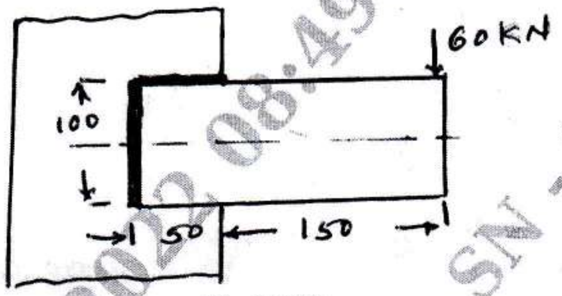

Fig.Q7(b) **(10 Marks)**

OR

8 a. Calculate the maximum force F that can be applied to the eccentrically loaded welded joint shown in Fig.Q8(a). If the size of the fillet welds 15 mm and have an allowable shear stress of 80 N/mm^2.

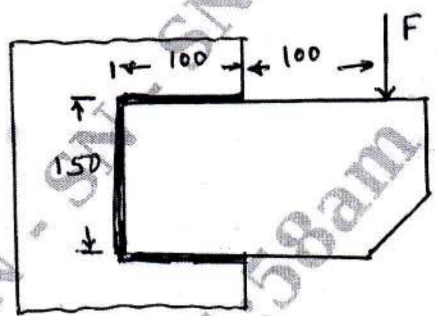

Fig.Q8(a) **(10 Marks)**

b. Determine the load carrying capacity for the joint shown in Fig.Q8(b). The allowable stress in the 20 mm diameter rivet is 100 N/mm^2.

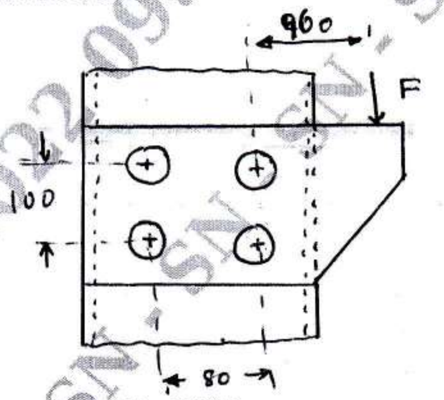

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Derive torque required to raise load on square threaded screw with usual notations. **(05 Marks)**

b. A split nut used with a lead screw is propelled at a speed of 5 m/min, against a load of 20 kN along the spindle of a square thread with single start having nominal diameter of 30 mm and pitch of 6 mm. The axial thrust is absorbed by a collar of 100 mm outside diameter and 70 mm inside diameter. Assume the coefficient of friction of thread is 0.14 and collar friction is 0.147. Determine: (i) Power required to drive (ii) Height of bronze nut required if allowable bearing pressure is 17 N/mm^2 (iii) Efficiency of drive. **(15 Marks)**

OR

10 a. What are the advantages and disadvantages of square thread over trapezoidal threads? **(05 Marks)**

b. The structural connection shown in Fig.Q10(b) is subjected to on eccentric force P of 10 kN with an eccentricity of 500 mm from C.G. of the bolts. The centre distance between bolts 1 and 2 is 200 mm; and the centre distance between bolts 1 and 3 is 150 mm. All the bolts are identical. The bolts are made from the plain carbon steel with $\sigma y = 400$ N/mm^2 and the factor of safety is 2.5. Determine the size of the bolts.

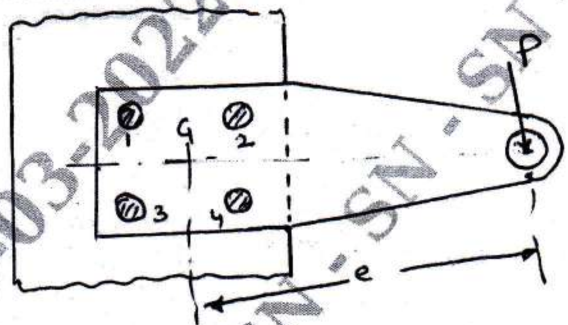

Fig.Q10(b) **(15 Marks)**

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