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10ME52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024

Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: ***1.Answer any FIVE full questions, selecting at least TWO full questions from each part.***
2. Use of design data hand book is permitted.

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.

PART – A

1 a. Write a note on triaxial stress system. **(05 Marks)**

b. Explain codes and standards used in machine design. **(05 Marks)**

c. Determine the thickness of the steel bracket loaded as shown in Fig.Q.1(c). **(10 Marks)**

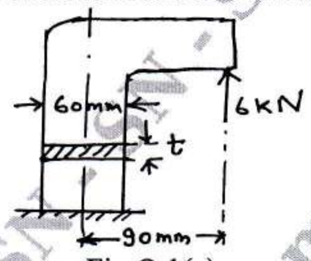

Fig.Q.1(c)

2 a. A mild steel shaft having yield stress 232N/mm^2 is subjected to the following stresses. σ_x = 120N/mm^2, σ_y = -60N/mm^2 and τ_{xy} = 36N/mm^2. Find the factor of safety using i) Maximum normal stress theory ii) Maximum shear stress theory iii) Distortion energy theory. **(06 Marks)**

b. A stepped shaft of diameter 1.5d is stepped down to diameter d with a fillet radius of 0.125d and carries a transverse load of 90kN as shown in Fig.Q.2(b). Determine the diameter of the shaft taking factor of safety 3. For the material of the shaft take σ_y = 480N/mm^2. **(06 Marks)**

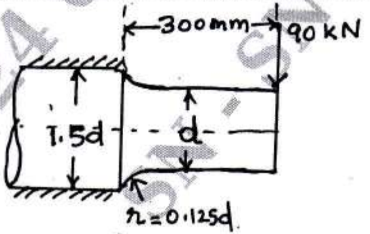

Fig.Q.2(b)

c. Derive an expression for impact stress in an axial bar of cross sectional area A and length L due to the impact of a load W falling over a height h on the bar. **(08 Marks)**

3 a. Derive Goodman equation for the design of component subjected to variable stress. **(06 Marks)**

b. A shaft subjected to bending moment varying from -200N-m to 500N-m and twisting moment varying from 15N-m (clock wise) to 175N-m (counter clockwise). The material is 30C8 steel and possesses following properties. Endurance strength σ_{ex} = 300MPa, σ_u = 490MPa and σ_y = 270Mpa. The correction factor for surface, size and load is given as 0.76, 0.76 and 0.87 respectively (for both in bending and torsion). Notch sensitivity factor 0.75 and stress concentration factor 1.85. Determine the diameter of shaft using factor of safety 1.5. **(14 Marks)**

4 a. A M20 × 2 steel bolt of 100mm long is subjected to impact load. The energy absorbed by the bolt is 2N-m. Determine:

i) The stress in the shank of the bolt, if there is no threaded portion between the nut and the bolt head.

ii) The stress in the shank if the entire length of bolt is threaded. Take $E = 206.8 \times 10^3$ N/mm^2. **(08 Marks)**

b. For supporting the crane in workshop, brackets are fixed on steel columns as shown in Fig.Q.4(b). The maximum load that comes on the bracket is 12kN acting vertically at a distance 400mm from the face of the column. The vertical face of the bracket is secured to a column by four bolts in two rows (two in each row) at a distance of 50mm from the lower edge of the bracket. Determine the size of the bolts if the permissible value of the tensile stress for the bolt material is $84N/mm^2$. Find the thickness of the bracket if the width of bracket is 250mm. **(12 Marks)**

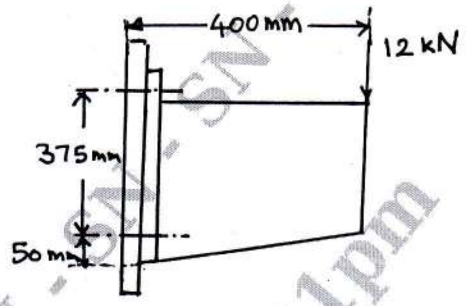

Fig.Q.4(b)

PART – B

5 a. With usual notations prove that a hollow shaft is always stronger than a solid shaft of the same material, weight and length when subjected to simple torque and prove that.

$$\frac{\text{Torque on hollow shaft}}{\text{Torque on solid shaft}} = \frac{1+k^2}{\sqrt{1-k^2}} \text{ where } K = \frac{D_1}{D_0}.$$ **(08 Marks)**

b. A line shaft is to transmit 30kW at 1600rpm. It is driven by means of belt running on a 1m diameter pulley keyed to the end of the shaft. The tension side of the belt is 2.5 times that on the slack side and the centre of the pulley over hungs 150mm beyond the centre line of end bearing. Determine the diameter of the shaft, if allowable shear stress is 60MPa and the pulley weighs 1600N. **(12 Marks)**

6 a. Select rectangular key for transmitting a power of 50kW at 500rpm for a hub length of 60mm. Take diameter of solid shaft as 50mm, allowable shear stress of $55N/mm^2$ and crushing stress as $110N/mm^2$. **(08 Marks)**

b. Design a knuckle joint to connect two mild steel rods, subjected to a tensile load of 90kN. The material selected for the joint has the following stresses. Allowable tensile stress = $90N/mm^2$, allowable shear stress = $60N/mm^2$ and allowable crushing stress = $150N/mm^2$. **(12 Marks)**

7 a. Design a double riveted double cover butt joint with unequal covers and zig-zag riveting to connect two plates of 25mm thick. Take $\sigma_t = 115\text{N/mm}^2$, $\tau = 70\text{N/mm}^2$ and $\sigma_c = 140\text{N/mm}^2$. **(10 Marks)**

b. Determine the size of the weld for the joint shown in Fig.Q.7(b). **(10 Marks)**

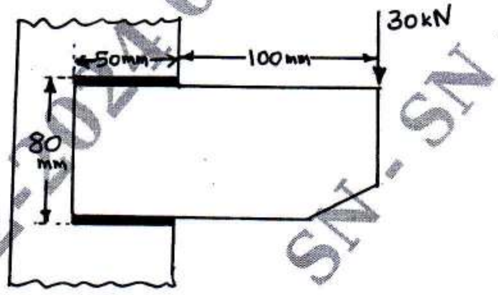

Fig.Q.7(b)

8 a. Derive an expression for torque required to raise the load. **(06 Marks)**

b. A triple threaded power screw is used in a screw jack, has a nominal diameter of 50mm and a pitch of 8mm. The threads are square shape and length of nut is 48mm. The screw jack is used to lift a load of 7.5kN. The coefficient of friction at the threads is 0.12 and collar friction is negligible. Calculate:

- i) The principal stresses in the screw rod
- ii) The transverse shear stress in the screw and nut
- iii) The bearing pressure for threads
- iv) State whether the screw is self locking
- v) Efficiency of screw. **(14 Marks)**

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