

END TERM EXAMINATION

FIFTH SEMESTER [B.TECH] DECEMBER 2024

Paper Code: MAC-303

Subject: Machine Design-I

Time: 3 Hours

Maximum Marks: 75

Note: Attempt five questions in all including Q.No.1 which is compulsory. Select one question from each unit. Use of scientific calculator is allowed. Kindly provide.

Q1 Answer the following: (2.5x10=25)

- (a) Explain the meaning of 30C4 as material designation.
- (b) What is S-N curve? Explain its significance.
- (c) What is Factor of Safety? Explain its importance in the design of mechanical elements.
- (d) Compare a Sunk key and a Saddle key by listing three key differences between them.
- (e) Define Mechanical Advantage and Leverage.
- (f) List various types of shaft couplings.
- (g) Why is it preferable to use butt joint than a lap joint?
- (h) In how many ways a riveted joint may fail?
- (i) List three differences between square threads and trapezoidal threads used in power screws.
- (j) What is pitting phenomena in gears? State its causes and remedy.

UNIT-I

- Q2 a) What is stress concentration? Under static loading, why stress concentration factor is ignored for ductile materials? (3.5)
- b) Design a Knuckle joint subjected to an axial pull of 25 kN. The safe working stresses for tension, shear and crushing are 100 N/mm², 60 N/mm² and 160 N/mm² respectively. Design should include figures for the Joint and failure areas. (9)

OR

- Q3 a) What are the different manufacturing considerations in the design of: (i) casting product (ii) forged component, and (iii) machine component? Explain each in detail with the help of suitable diagrams. (7)
- b) A machine component is subjected to bending stress which fluctuates between +300 MPa and -150 MPa. Determine the value of the minimum ultimate strength according to: (i) Soderberg (ii) Goodman, and (iii) Gerber criteria. Assume factor of safety = 2, endurance limit as 0.5 times of ultimate strength and yield strength as 0.55 times of ultimate strength. (5.5)

UNIT-II

- Q4 A line shaft carrying two pulleys A and B is supported by two bearings placed 900 mm apart. Pulley A (250 mm diameter) is mounted at a distance of 250 mm to the right of right hand bearing while pulley B (450 mm diameter) is mounted at a distance of 450 mm to the left of right hand bearing. Power is supplied to the shaft by means of a vertical belt on the pulley A, which is then transmitted to the pulley B carrying a horizontal belt. The ratio of belt tension on tight and loose sides is 3:1. The limiting value of tension in the belts is 2.7 kN. The shaft is made of plain carbon steel 40C8 ($S_{ut} = 650 \text{ N/mm}^2$ and $S_{yt} = 380 \text{ N/mm}^2$). The pulleys are keyed to the shaft. Design and draw the shaft according to the ASME code if, fatigue factors: $k_b = 1.5$ and $k_t = 1.0$. Neglect the weight of pulleys. (12.5)

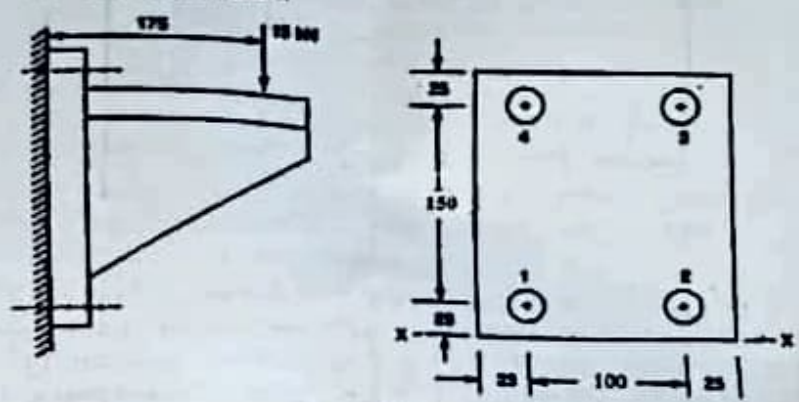
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Q5 OR
 A helical compression spring made of oil tempered carbon steel is subjected to a load which varies from 400 N to 1000 N. The spring index is 6 and the design factor of safety is 1.25. If the yield stress in shear is 770 MPa and endurance strength in shear is 350 MPa. Find i) size of the spring wire ii) spring coil diameter iii) number of spring-turns and iv) free length. The compression of the spring at maximum load is 30 mm and the rigidity modulus G is 80 GPa. Take Wahl's curvature effect into consideration. Assume the end conditions as squared and ground. (12.5)

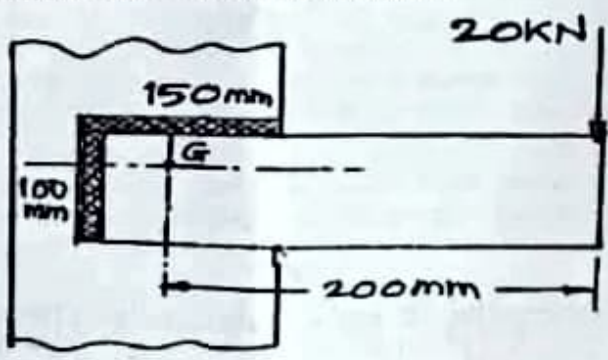
UNIT-III

Q6 a) What is meant by preloading/pre-tension in bolts? (3.5)
 b) A steel bracket as shown in Figure (dimensions in mm) is secured to a wall by means of 4 steel bolts. The load on the bracket is 15 kN which acts at a distance of 175 mm from the wall. Determine the size of the bolt. (9)



OR

Q7 a) What is throat in the design of welded joint? Write the relation of throat thickness and size of weld in fillet welds? (3.5)
 b) Figure shows a welded joint subjected to an eccentric load of 20 kN. Determine the size of weld on entire length of two legs. Take permissible shear stress as 100 MPa. (9)



UNIT-IV

Q8 a) What are power screws? Perform a force analysis of a square-threaded power screw, including a relevant diagram, and derive the equations for the torque needed to lift and lower a load. (8)
 b) Compare self-locking and overhauling conditions in power screws. What factors influence whether a screw will be self-locking or tend to overhaul? (4.5)

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OR

- Q9 a) Using diagrams and relevant equations, explain the force analysis in a spur gear, focusing on tangential and radial loads. Which of these loads is responsible for power transmission? (8)
- b) Define the beam strength of spur gear tooth. Explain the Lewis beam equation for determining the bending strength of spur gear teeth. List the key assumptions made and discuss their impact on its practical application in gear design. Include relevant diagrams and equations. (4.5)
