CBCS SCHEME

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18ME52

Fifth Semester B.E. Degree Examination, June/July 2024
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 data book is permitted.***
3. ***Any missing data may suitably assume.***

Module-1

1 a. Explain the importance of standards in design. List the different types of standards in use. **(05 Marks)**

b. Briefly discuss the factors influencing the selection of suitable materials for machine elements. **(05 Marks)**

c. A 50 mm steel rod supports a 9 kN load and in addition to this torsional moment of 100 N-m is applied on it as shown in Fig.Q1(c). Determine the maximum tensile and maximum shear stresses.

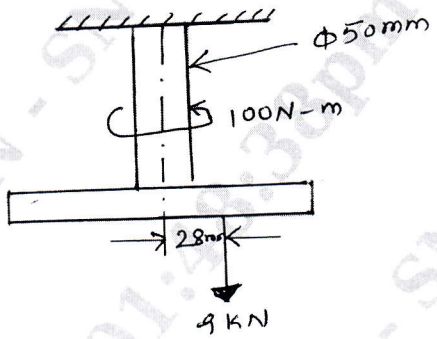

Fig.Q1(c) **(10 Marks)**

OR

2 a. Explain the following theories of failure:
(i) Maximum Normal Stress Theory
(ii) Maximum Shear Stress Theory **(05 Marks)**

b. Define stress concentration. Describe any two methods used to minimize the stress concentration. **(05 Marks)**

c. Determine the safe load that can be carried by a bar of rectangular cross-section shown in Fig.Q2(c), limiting the maximum stress to 130 MPa taking stress concentration into account.

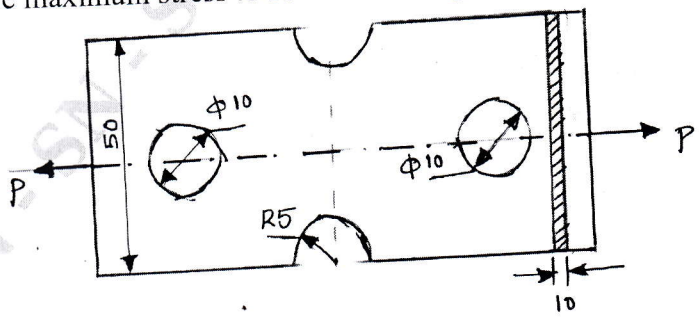

Fig.Q2(c) **(10 Marks)**

Module-2

3 a. Define impact load. Derive an expression for impact stress in a axial bar of C/S "A" and length "L" due to the impact load "W" falling from a height "h" from the collar. **(08 Marks)**

b. A cantilever beam of width 50 mm, depth 150 mm is 1.5 m long. It is struck by a weight of 1000 N that falls from a height of 10 mm at its free end. Determine the following:

(i) Impact factor
(ii) Instantaneous maximum deflection
(iii) Instantaneous maximum stress
(iv) Instantaneous maximum load

Take $E = 20.6 \times 10^4$ N/mm^2 **(12 Marks)**

OR

4 a. Explain briefly fatigue load and LCF (Low Cycle Fatigue). **(04 Marks)**

b. A transmission shaft carries a pulley midway between two bearings. The bending moment at the pulley varies from 200 N-m to 600 N-m as the torsional moment of the shaft varies from 70 N-m to 200 N-m. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is made of steel FiE (σ_u = 540 MPa, σ_y = 400 MPa). The corrected endurance strength of the shaft is 200 MPa. Determine the diameter of the shaft, using FoS = 2. **(16 Marks)**

Module-3

5 A horizontal piece of commercial shafting is supported by two bearings 1.5 m apart. A keyed gear 20° involute and 175 mm in diameter is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 to 1, with the slack side on top. The drive transmits 45 KW at 330 rpm. Take $C_m = C_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflection in degrees. Use allowable shear stress 40 MPa and $G = 80 \times 10^9$ N/mm^2. **(20 Marks)**

OR

6 a. Prove that square key is equally strong in shear and compression. **(06 Marks)**

b. Design a protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and the allowable shear stress in the flange is 40 MPa. **(14 Marks)**

Module-4

7 a. List the assumptions made for designing the riveted joint for pressure vessels. **(06 Marks)**

b. Design a triple riveted butt joint two plates of thickness 10 mm. The pitch of rivets in the extreme rows, which are in single shear is twice the pitch of rivets in the inner rows which are double shear. The design stresses of the materials of the main plate and the rivets are as follows:

For plate material in tension, σ_t = 120 MPa
For rivet material in compression σ_c = 160 MPa
For rivet material in shear τ = 80 MPa **(14 Marks)**

OR

8 a. What are advantages of welded joints over riveted joint? **(06 Marks)**

b. A welded connection of steel plates as shown in Fig.Q8(b) is subjected to an eccentric load of 10 kN. Determine the throat dimension of weld, if the permissible stress is limited to 95 N/mm^2. Assume static conditions.

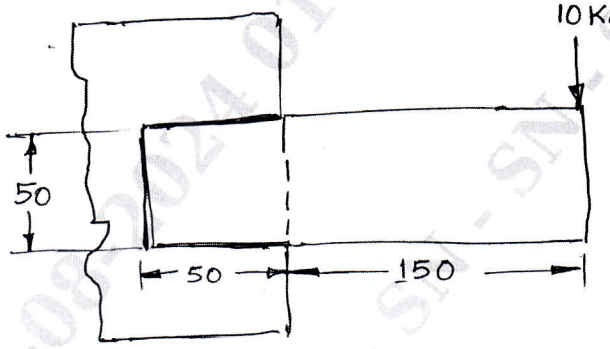

Fig.Q8(b) **(14 Marks)**

Module-5

9 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 flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto the pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100 N/mm^2. **(10 Marks)**

OR

10 a. Explain self locking and overhauling in power screws. **(04 Marks)**

b. A screw jack is to lift a load of 80 kN through a height of 400 mm. Ultimate strength of screw material in tension and compression is 200 N/mm^2 and in shear 120 N/mm^2. The material for nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension and 90 N/mm^2 in compression and 80 N/mm^2 in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Design the screw and nut and check for the stresses. Take FoS = 2. Assume 25% overload for screw rod design. **(16 Marks)**

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