CBCS SCHEME

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18ME52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
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 handbook is permitted.***

Module-1

1 a. Discuss the factors influencing the selection of suitable material for machine element. **(08 Marks)**

b. Determine the safe load that can be carried by a bar of rectangular cross section shown in Fig.Q1(b). Limiting the maximum stress to 130 MPa taking stress concentration into account and assume thickness of bar as 10 mm.

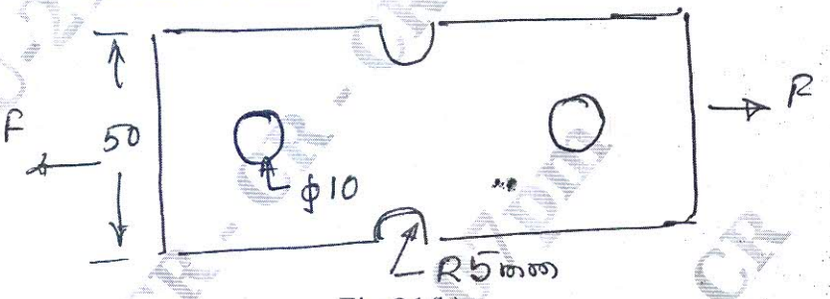

Fig.Q1(b) **(12 Marks)**

OR

2 a. Explain the following theories of failure :
(i) Maximum normal stress theory
(ii) Maximum shear stress theory
(iii) Distortion energy theory **(10 Marks)**

b. A machine element made of C45 steel is subjected to a system of loads, following stresses are induced at critical point:
σ_x = 150 MPa, σ_y = 100 MPa and τ_{xy} = 50 MPa
Find the factor of safety according to:
(i) Maximum normal stress theory
(ii) Maximum shear stress theory
(iii) Distortion energy theory **(10 Marks)**

Module-2

3 a. Derive Soderberg's equation. **(06 Marks)**

b. A hot rolled steel rod is subjected to torsional load that varies from +330 N-m clockwise to 110 N-m counter clockwise and an applied bending moment varies from +440 N-m to –220 N-m. The rod is of uniform cross section. Determine the required diameter rod. The material has an ultimate tensile strength of 550 MPa and yield strength of 410 MPa. Assume a factor of safety 1.5. Take the endurance limit as half of the ultimate strength. **(14 Marks)**

OR

4 a. List and explain the various factors effecting the endurance limit of the material. **(08 Marks)**

b. An unknown weight falls through 20 mm as to a collar rigidly attached to the lower end of a vertical bar 2 meter long and 500 mm^2 section. If the maximum instantaneous extension is 2 mm. What is the corresponding stress and the value of unknown weight? Take E = 200 GPa. **(06 Marks)**

c. A cantilever beam of span 800 mm has a rectangular cross section of depth 200 mm. The free end of beam is subjected to a transverse load of 1 kN that drops on to it from a height of 40 mm. Selecting C40 steel as material and a factor of safety 2. Determine the width of rectangular cross section. Assume E = 200 GPa. **(06 Marks)**

Module-3

5 A commercial shaft 1 metre long supported between bearings has a pulley of 600 mm diameter weighing 1 kN, driven by a horizontal belt drive keyed to the shaft at a distance of 400 mm to the left of the right bearing and receives 25 KW at 1000 rpm. Power from the shaft is transmitted from the 20° spur pinion of a pitch circle diameter 200 mm which is mounted at 200 mm to the right of the left bearing to a gear such that tangential force on gear acts vertically upwards. Take the ratio of the belt tension is 3. Determine the standard size of the shaft based on maximum shear stress theory. Assume $C_m = 1.75$, $C_t = 1.25$. **(20 Marks)**

OR

6 a. Compare weight, strength and stiffness of hollow shaft of same external diameter of that solid shaft. The inside diameter being half the external diameter. Both the shafts have same material and length. **(06 Marks)**

b. Design a cast iron flanged coupling for a steel shaft transmitting 100 KW at 250 rpm. Take the allowable shear stress for the shaft as 40 N/mm^2. The angle of twist is not to exceed 1° in a length of 20 diameters. Allowable shear stress for the bolts is 13 MPa. The allowable shear stress in the flange is 14 MPa for the key is 40 MPa. Allowable compressive stress in key is 80 MPa. **(14 Marks)**

Module-4

7 a. Explain in detail various possible modes of failure of riveted joint. **(06 Marks)**

b. Design a double riveted butt joint with two equal cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 75% allowable tensile stress in the plate of 90 N/mm^2, allowable crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet of 50 N/mm^2. **(14 Marks)**

OR

8 a. A bracket having a load of 15 kN is to be welded as shown in Fig.Q8(a). Find the size of weld required, if allowable shear stress is not to exceed 80 N/mm^2.

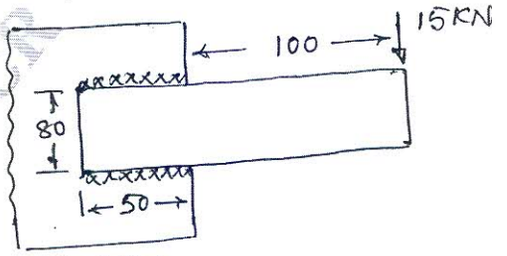

Fig.Q8(a) **(10 Marks)**

b. Determine the size of rivets required for the bracket shown in Fig.Q8(b). Take allowable shear stress of rivet material as 100 N/mm^2.

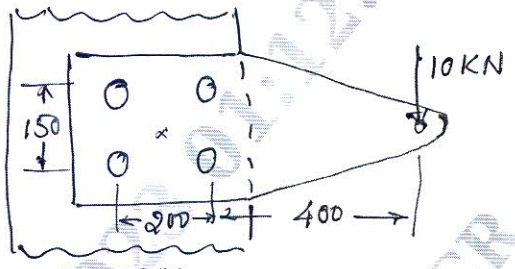

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Obtain an expression for torque required to lift the load on a square threaded screw. **(08 Marks)**

b. Design a socket and Spigot type cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses σ_t = 100 N/mm^2, σ_c = 150 N/mm^2 and τ = 60 N/mm^2. **(12 Marks)**

OR

10 a. Explain self locking and overhauling of power screw. **(06 Marks)**

b. The cotter of a broaching machine is pulled by square threaded screw of 55 mm external diameter and 10 mm pitch. The operating nut takes the axial load of 400 N. On a flat surface of 60 mm and 90 mm internal and external diameters respectively. If the coefficient of friction is 0.15 for all contact surfaces, determine the power required to rotate the nut when the cutting speed is 6 m/min. Also find the efficiency of the screw. **(14 Marks)**

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