CBCS SCHEME

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18MT52

Fifth Semester B.E. Degree Examination, June/July 2024
Design and Analysis of Machine Elements

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define Machine Design. Explain classification of machine design. **(08 Marks)**

b. Define Factor of Safety (FoS). **(02 Marks)**

c. Design a spindle of milling machine to transmit 15 KW at 1000 rpm. The angular twist is not to exceed 0.5° per meter length. The material for the spindle is 45C8 steel (σ_{yt} = 360 MPa). The outside diameter of the spindle is twice that of inside diameter. Take FoS = 2. **(10 Marks)**

OR

2 a. Explain maximum normal stress theory and maximum shear stress theory. **(10 Marks)**

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

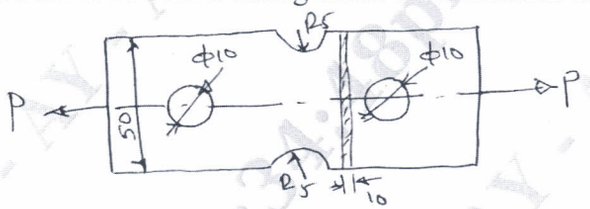

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Define the following:

(i) Fatigue load (ii) Stress cycle (iii) Fluctuating stress

(iv) Repeated stress (v) Stress ratio (vi) Mean stress **(06 Marks)**

b. A piston rod is subjected to a maximum reversed axial load of 110 kN. It is made of steel having an ultimate stress of 900 N/mm^2 and the surface is machined. The average endurance limit is 50% of the ultimate strength. Take the size correction coefficient as 0.85 and FoS = 1.75. Determine the diameter of the rod. **(14 Marks)**

OR

4 a. Explain Soderberg criterion and Goodman criterion with diagram. **(10 Marks)**

b. A steel shaft is subjected to a bending moment varies from 100 Nm to 200 Nm and transmits 10 KW at 150 rpm. The torque varies over a range of ±40%. The shaft is made of steel whose yield stress = 400 N/mm^2 and endurance stress = 300 N/mm^2. Surface coefficient factor = 0.9, size factor = 1.2, FoS = 5. Stress concentration factor = 1.94. Determine the diameter of shaft for infinite life. **(10 Marks)**

Module-3

5 a. Derive torque required to lift the load on square thread screw. **(10 Marks)**

b. Write general design procedure for power screw. **(10 Marks)**

OR

6 a. Define the following:
(i) Solid length (ii) Free length (iii) Spring index
(iv) Spring rate (v) Pitch **(05 Marks)**

b. Design a helical compression spring to support an axial load of 300 N. The deflection under load is limited to 60 mm. The spring index is 6. The spring is made of chrome-vanadium steel and FoS is equal to 2. **(15 Marks)**

Module-4

7 a. Explain different standard systems of gear tooth. **(06 Marks)**

b. Two spur gears are to be used for a rock crusher drive and are to be of minimum size. The gears are to be designed for the following requirements, power to be transmitted is 18 kW, speed of pinion 1200 rev/min, velocity ratio 3.5 to 1, tooth profile 20° sub involute. Determine module and face width for strength requirements only. **(14 Marks)**

OR

8 a. Derive beam strength of helical gear. **(06 Marks)**

b. Design a pair of helical gears to transmit power of 15 kW at 3200 rpm with speed reduction 4:1 pinion is made of cast steel 0.4% C untreated. Gear is made of high grade CI. Helix angle is limited to 26° and not less than 20 teeth are to be used on either gear. Suggest suitable surface hardness for the gear pair. **(14 Marks)**

Module-5

9 a. Define FEM. List advantages, limitations and applications of FEM. **(06 Marks)**

b. List different steps involved in FEM. **(04 Marks)**

c. For the continuum as shown in Fig.Q9(c). Determine the nodal displacement, reactions at the supports. Take E = 200 GPa. (By using penalty method)

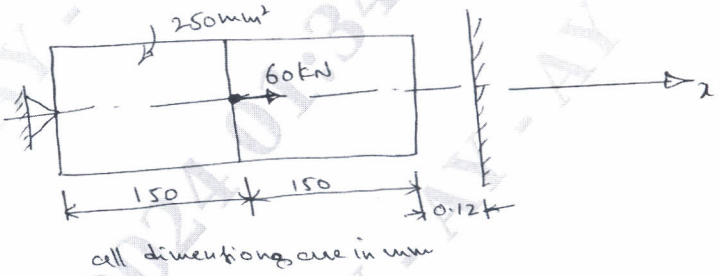

Fig.Q9(c) **(10 Marks)**

OR

10 a. Derive stiffness matrix for bar element. **(08 Marks)**

b. For a step bar as shown in Fig.Q10(b). Determine the nodal displacement, reactions at supports and stresses in each element by using elimination approach. Take E = 2×10^5 MPa.

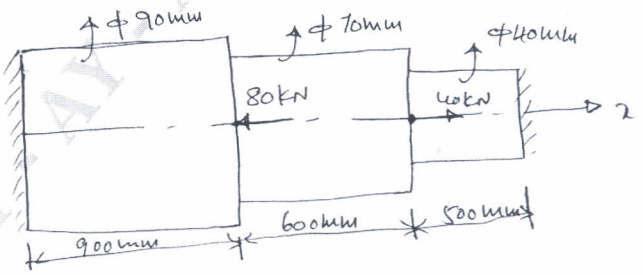

Fig.Q10(b) **(12 Marks)**

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