CBCS SCHEME

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18MT52

Fifth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Design and analysis of Mechanical Elements

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What is Mechanical Engineering Design? Explain the steps involved in design with a block diagram. **(08 Marks)**

b. A circular rod of diameter 50 mm is subjected to loads as shown in Fig Q1(b). Determine the nature and magnitudes of stresses at the critical points.

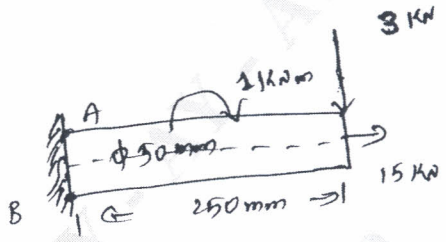

Fig Q1(b) **(12 Marks)**

OR

2 a. State and explain the following theories of failure
i) Maximum shear stress theory
ii) Distortion energy theory
iii) Maximum normal stress theory **(08 Marks)**

b. A mild steel shaft is subjected to 3500 N-m of bending moment of its critical point and transmits a torque of 2500 N-m. The shaft is made of steel having yield strength of 231 MPa. Estimate the size of the shaft based on the following theories of failure.
i) Maximum normal stress theory
ii) Maximum shear stress theory **(12 Marks)**

Module-2

3 a. Define endurance limit. List the factors affecting endurance limit. Explain any one factor. **(06 Marks)**

b. A steel member of circular cross section is subjected to a torsional stress that varies from 0 to 35 MPa and at the same time it is subjected to an axial stress that varies from – 14 MPa to + 28 MPa. Neglecting stress concentration and column effect and assuming that the maximum stresses in torsion and axial load occur at the same time. Determine :
i) Maximum equivalent shear stress
ii) The design factor of safety based on yield in shear
The material has an endurance limit σ_{-1} = 206 MPa and yield strength of σ_y = 480 MPa. The diameter of the member is less than 12 mm. The load concentration factor = 1. Surface limits factor is equal 1. **(14 Marks)**

OR

4 a. Derive Soderberg's relation for a member subjected to fatigue loading. **(05 Marks)**

b. Determine the maximum load for the simply supported beam is cyclically loaded as shown in Fig Q4(b). The ultimate strength is 700 MPa. The yield point in tension is 520 MPa and the endurance limit in reversed bending is 320 MPa. Use a factor of safety of 1.25. The load, size and surface correction factors are 1, 0.75 and 0.9 respectively.

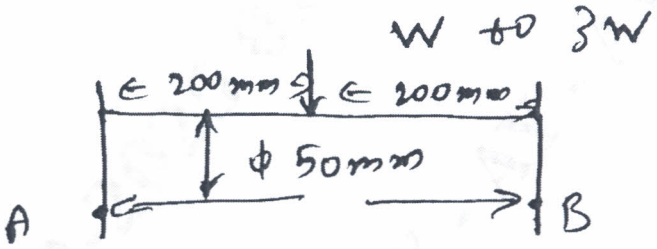

Fig Q4(b) **(15 Marks)**

Module-3

5 a. What is self locking of a power screw? Derive an equation for torque required to raise the load on a square thread. **(10 Marks)**

b. The lead screw of a machine has single start trapezoidal threads of 30 mm outline diameter and 6 mm pitch. It drives the tool carriage against an axial load of 1500 N. The thrust collar has a mean diameter of 40 mm. The carriage is moved at a speed of 0.72 m/sec. The coefficient of friction per both screw and collar is 0.14. Find the power required to drive the screw and the required to drive the screw and the efficiency. **(10 Marks)**

OR

6 a. What is surging in helical springs and how it can be eliminated? **(04 Marks)**

b. A rail way wagon weighing 50 kN and moving with a speed of 8 Km/hours has to be stopped by 4 butter springs in which the maximum compression allowed is 220 mm. Find the number of turns or with a each spring of mean diameter 150 mm. The diameter of spring wire is 25 mm. Take G = 84 GPa. Also find the shear stresses. **(08 Marks)**

c. A locomotive spring has overall length of 1100 mm and sustain a load of 75 kN at its centre. The spring has 3 full length leaves and 15 graduated leaves with a central band of 100 mm. All the leaves are to be stressed at 0.4 GPa when fully loaded. The ratio of total spring depth to width is 10. Determine :

i) Width and thickness of leaves
ii) Initial gap that must be provided between full length and graduated leaves before the load is applied.
iii) What load is exerted on the band after the spring is assembled? **(08 Marks)**

Module-4

7 Design a pair of spur gears to transmit 20 kW from a shaft rotating at 1000 rpm to a parallel shaft, which is to rotate at 310 rpm. Assume the number of teeth on pinion 31 and 20° full depth form the material for pinion is C45 steel untreated and for gear cast steel 0.20 % C untreated. **(20 Marks)**

OR

8 A pair of carefully cut (cross – II) helical gears for a turbine has a transmission ratio of 10 : 1. The teeth are 20° stub involute in the normal phase. Pinion has 25 teeth and rotates at 5000 rpm. Material for pinion and gear is 0.4% Carbon steel un-treated. Determine the module in Normal plane, diametral plane and face width of the gears. Suggest suitable hardness. Modulus of electricity may be taken of 210 GPa. Helix angle = 30°, power transmitted = 90 kW. **(20 Marks)**

Module-5

9 a. What is FEM? Explain the basic steps involved in FEM. **(10 Marks)**

b. Discuss the type of element based on geometry and explain Node numbering schemas. **(10 Marks)**

OR

10 a. Write the properties of stiffness matrix and derive the elemental stiffness matrix for 1-D bar element. **(10 Marks)**

b. A bar is having uniform cross sectional area of 300 mm^2 and is subjected to a load P = 600kN of shown in Fig Q10 (b).

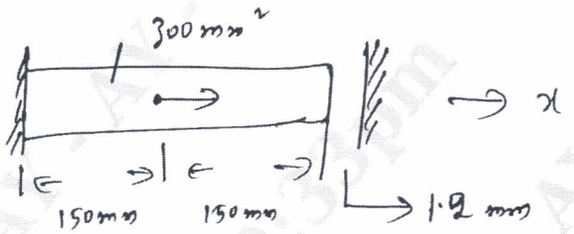

Fig Q10(b)

Determine the displacement field stress, consider two elements model and use elimination method to handle boundary condition. Take E = 200 GPa. **(10 Marks)**

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