CBCS SCHEME

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18MT52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Design and Analysis of Machine Elements

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.
3. Missing data may be suitably assumed.

Module-1

1 a. Explain the following :
(i) Machine design (ii) Codes (iii) Standards (iv) Stress concentration **(08 Marks)**

b. Determine the maximum stress in the following cases taking stress concentration into account.
(i) A rectangular plate of 50mm × 80mm with a hole of 10mm diameter in the centre is loaded in axial tension of 10 kN. Thickness of the plate is 10mm.
(ii) A circular shaft of 45mm diameter stepped down to 30mm diameter having a fillet radius of 6mm subjected to a twisting moment of 150 Nm. **(12 Marks)**

OR

2 a. Explain the following theories of failure:
(i) Maximum principal stress theory
(ii) Maximum shear stress theory
(iii) Maximum distortion energy theory. **(06 Marks)**

b. A rod of circular section is to sustain a torsional moment of 300 kNm and bending moment 200 kNm, Selecting C45 steel (σ_{yt} = 353 MPa) and assuming factor of safety = 3, determine the diameter of rod as per following theories of failure,
(i) Maximum shear stress theory
(ii) Distortion energy theory
(iii) Total energy theory
(iv) Maximum principal stress theory. **(14 Marks)**

Module-2

3 a. Derive the Soderberg's equation. **(10 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 co-efficient as 0.85 and a factor of safety = 1.75. Determine the diameter of the rod. **(10 Marks)**

OR

4 a. Derive the Goodman's equation. **(10 Marks)**

b. A beam of SAE 2320 steel oil quenched (σ_u=516.8 MPa, σ_y = 331.5 MPa. σ_{-1} = 316.8 MPa) is subjected to a load causing a bending stress of 200 N/mm^2.
i) Find the factor of safety if the load is steady.
ii) Find the factor of safety if the stress is varying between –150 N/mm^2 and 200 N/mm^2 and the stress concentration factor is 1.2
iii) Find the factor of safety if the stress is completely reversed.
Take the load and size correction coefficients as 1 and 0.9 respectively. **(10 Marks)**

Module-3

5 a. Derive an expression for torque required to lift the load on square threaded screw. **(10 Marks)**

b. A split nut used with a lead screw is propelled at a speed of 5 m/min, against a load of 20 kN, along the spindle of a square thread (single start) having nominal diameter of 30mm and pitch of 6mm.The axial thrust is absorbed by a collar of 100mm outside diameter and 70mm inside diameter. Assuming suitable coefficient of friction, determine

(i) Power required to drive

(ii) Height of bronze nut required if allowable bearing pressure is 17 MPa.

(iii) Efficiency of the drive. **(10 Marks)**

OR

6 a. Derive an expression for stress in helical springs of circular wire. **(08 Marks)**

b. A cloud helical spring is to have a stiffness of 1 N/mm, maximum load of 40 N and maximum shear stress of 130 N/mm^2. The solid length is 45mm. Find the diameter of wire and number of coils required. Take G = 80 GPa. **(12 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 number of teeth on pinion 31 and 20° full depth tooth form. The material for pinion is C45 steel untreated and for gear cast steel 0.20% C untreated. **(20 Marks)**

OR

8 Design a pair of helical gear to transmit 12 kW at 2400 rpm of pinion. The velocity ratio required is 4:1, helix angle is 23°. The centre distance is to be around 300 mm. Pressure angle in the normal plane is 14½° involute. Pinion material is cast steel ASTM class B. Gear material is cast iron better grade. **(20 Marks)**

Module-5

9 a. Define FEM. What are the advantages , disadvantages and applications of FEM. **(08 Marks)**

b. Explain the steps involved in FEM. **(12 Marks)**

OR

10 a. Derive the equation for stiffness matrix of bar element. **(10 Marks)**

b. Explain the different types of elements. **(06 Marks)**

c. Define node and element. **(04 Marks)**

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