CBCS SCHEME

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18MT52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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 machine design data handbook is permitted.***
3. ***Any missing data may be suitably assumed.***

Module-1

1 a. Explain the standards and codes used in design. **(04 Marks)**

b. Explain the phases of design. **(08 Marks)**

c. A bar of rectangular section is subjected to an axial pull of 500 kN Fig.Q1(c). Calculate its thickness if the allowable tensile stress in the bar is 200 MPa.

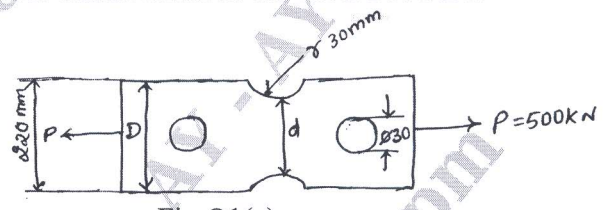


Fig.Q1(c) **(08 Marks)**

OR

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

b. A mild steel shaft of 60 mm diameter is subjected to a bending 25×10^5 N-mm and torque M_t. If the yield point of steel in tension is 230 N/mm^2. Find the maximum value of this torque without causing yielding of the shaft according to:
(i) Maximum principal stress theory or normal stress theory
(ii) Maximum shear stress theory
(iii) Maximum distrosion energy theory
Adopt a F.O.S. (Factor of Safety) 1.5. **(12 Marks)**

Module-2

3 a. Define Low Cycle Fatigue and High Cycle Fatigue. **(04 Marks)**

b. Define Endurance limit and explain the any two factors affecting it. **(06 Marks)**

c. A cantilever beam made of cold drawn carbon steel (σ_u = 500 MPa, σ_y = 470 MPa, σ_{-1} = 275 MPa) of circular cross section is subjected to load which varies from –F to 3F. Determine the maximum load that this member can withstand for an indefinite life. Using a factor of safety of 2. [Refer Fig.Q3(c)]

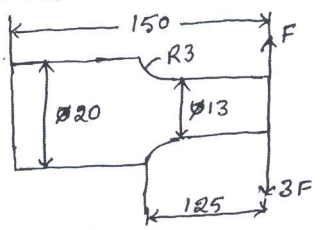


Fig.Q3(c) **(10 Marks)**

OR

4 a. Derive an expression for Soderberg criterion. **(05 Marks)**

b. A round rod of diameter 1.2d is reduced to a diameter 'd' with a fillet radius of 0.1d. This stepped rod is to sustain a twisting moment that fluctuates between +2.5 kN-m and +1.5 kN-m together with a bending moment that fluctuates between +1 kN-m and –1kN-m. The rod is made of carbon steel C_{40} (σ_y = 328.6 MPa; σ_u = 620 MPa). Determine a suitable value for 'd'. **(15 Marks)**

Module-3

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

b. A single start square threaded power screw is used to raise a load of 120 kN. The screw has a mean diameter if 24 mm and four threads per 24 mm length. The mean collar diameter is 40 mm. The coefficient of friction is estimated as 0.1 for both the thread and the collar. Determine: (i) Major diameter of the screw (ii) Screw torque required to raise the load (iii) Overall efficiency **(10 Marks)**

OR

6 a. Define spring index and derive an expression for deflection of helical spring of circular cross section wire. **(10 Marks)**

b. A railway wagon weighing 50 kN and moving with a speed of 8 km/hr has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns or coils in each spring of mean diameter 150 mm. The diameter of spring wire is 25 mm. Take G = 84 GPa. Also find shear stress. **(10 Marks)**

Module-4

7 Design a pair of spur gears to transmit a power of 18 KW from a shaft running at 1000 rpm to a parallel shaft to be run at 250 rpm maintaining a distance of 160 mm between the shaft centres. Suggest suitable surface hardness of for the gear pair. **(20 Marks)**

OR

8 Design a pair of helical gears to transmit power of 15 KW at 3200 rpm with high speed reduction 4:1 pinion is made of cast steel 0.4% C untreated. Gear made of high grade C.I. 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. **(20 Marks)**

Module-5

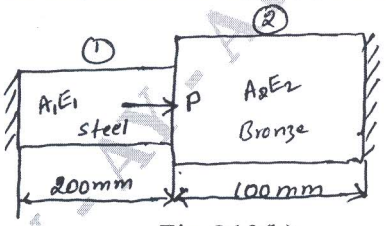
9 a. Explain the steps involved in FEM. **(10 Marks)**

b. Mention any three advantages, disadvantages and applications in FEM. **(10 Marks)**

OR

10 a. Explain the 1D, 2D, 3D elements with examples. **(10 Marks)**

b. The structure consists of two bars an axial load P = 200 kN is loaded as shown in Fig.Q10(b). Determine:
(i) Element stiffness matrix (ii) Global stiffness matrix (iii) Global load vector
(iv) Nodal displacements (v) Stress in each bar (vi) Reaction forces



$A_1 = 1000\ mm^2$
$A_2 = 2000\ mm^2$
$E_1 = 200\ GPa$
$E_2 = 83\ GPa$

Fig.Q10(b) **(10 Marks)**

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