CBCS SCHEME

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18MT52

Fifth Semester B.E. Degree Examination, June/July 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 hand book is permitted.

Module-1

1 a. State and explain design considerations. **(10 Marks)**

b. A bolt is subjected to a normal load of 18 kN and a shear load of 12 kN. The material has yield stress of 328.6 MPa. Determine the diameter of bolt according to Rankine's theory. Maximum shear stress theory and Von Mises theory. Take factor of safety of 2.5. **(10 Marks)**

OR

2 a. A bar of rectangular section is subjected to an axial pull of 500 kN. Calculate its thickness if the allowable tensile stress in the bar is 200 MPa.

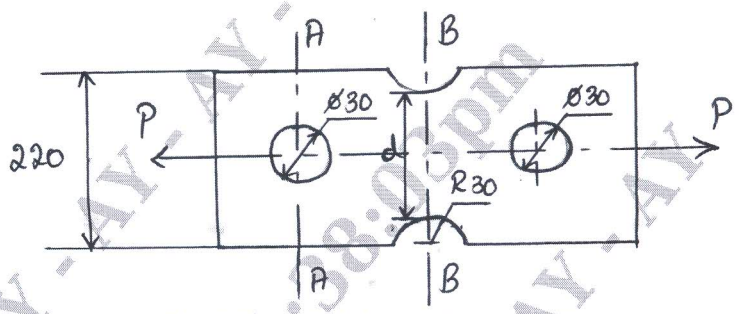

Fig.Q2(a) All dimensions are in mm **(10 Marks)**

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

Module-2

3 a. A steel rod subjected to a tensile load which varies from 120 kN to 40 kN. Find the diameter using "Soderberg Diagram". Take yield stress as 689.4 MPa and the endurance limit as 427.6 MPa. Adopt factor of safety as 2. Stress concentration factor as unity. Corretion factors for load, size and surface as 0.75, 0.85 and 0.91 respectively. **(10 Marks)**

b. Explain briefly the factors affecting the endurance limit. **(10 Marks)**

OR

4 a. A cantilever beam shown in Fig.Q4(a) is subjected to load variation from –F to 3F. Determine the maximum load that this member withstand for an infinite life, using a factor of safety 2. The material of the beam has an ultimate stress of 620.8 MPa, yield stress of 400.1 MPa and endurance limit of 345.2 MPa. Take correction factors for load, size and surface as 1, 0.85 and 0.81 respectively.

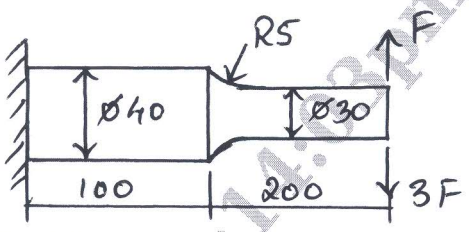

Fig.Q4(a) All dimensions are in mm **(10 Marks)**

b. Explain the following:
   (i) Soderberg criterion
   (ii) Cumulative fatigue damage **(10 Marks)**

Module-3

5 a. A triple threaded power screw is used in a screw jack has a nominal diameter of 50 mm and a pitch of 8 mm. The threads are square shape and length of the nut is 48 mm. The screw jack is used to lift a load of 7.5 kN. The coefficient of friction at the threads is 0.12 and collar friction is negligible. Calculate:
   (i) Principal shear stress in the screw rod.
   (ii) Transverse shear stress in the screw and nut.
   (iii) Unit bearing pressure for threads.
   (iv) State whether the screw is self locking. **(12 Marks)**

b. Derive an expression for torque required to lift the load on square threaded screw. **(08 Marks)**

OR

6 a. Design a helical compression spring to support an axial load of 3000 N. The deflection under load is limited to 60 mm. The spring index is 6. The spring is made up of chrome-vanadium steel with permissible shear stress of 345 MPa and modulus of rigidity of 79.34 GPa. **(10 Marks)**

b. A helical valve spring is to be designed for an operating load range of approximately 90 to 135 N. The deflection of the spring for the load range is 7.5 mm. Assume a spring index of 10 and factor of safety of 2. Design the spring. Take $\tau_y = 690$ MPa and $G = 79.34$ GPa. **(10 Marks)**

Module-4

7 A reciprocating machine running at 360 rpm is driven by 12 KW, 1440 rpm motor through a 14 ½° involute spur gear. The center distance between the drive being 250 mm. The pinion is made of heat treated cast steel of 450 BHN and the gear is of untreated cast steel. Assume light shock conditions and 8 hours per day operations. The allowable static stress of pinion is 193.2 N/mm^2 and allowable static stress of gear is 138.3 N/mm^2. Take number of teeth on pinion $Z_1 = 20$. Determine: (i) Module and face width (ii) Check the gear for wear **(20 Marks)**

OR

8 A pair of helical gears are used to transmit 75 KW at a pinion speed of 1200 rpm. The gear has to rotate at 400 rpm. The loading may be assumed as medium shock 8-10 hrs per day and gears are manufactured by gear hobbing process. Both gears are made up of steel material with $\sigma_d = 240$ MPa. Face width can be assumed as 15 mm. Determine module, face width, number of teeth and suggest suitable hardness. Assume tooth profile as 20° FDI and the helix angle as 23°. Take wear and lubrication factor $C_W = 1.15$, consider minimum number of teeth on pinion as $Z_1 = 18$ teeth with class II accuracy. **(20 Marks)**

Module-5

9 a. With an example briefly explain the basic steps involved in finite element method. **(12 Marks)**

b. What are the advantages and disadvantages of FEM? **(08 Marks)**

OR

10 a. Derive shape function for 1D bar element in natural coordinate system. **(10 Marks)**

b. A stepped bar is subjected to a load as shown in Fig.Q10(b). Determine nodal displacements and stress in each element. Take E = 200 GPa.

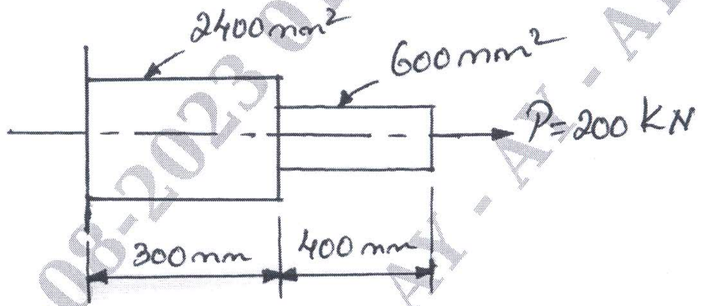

Fig.Q10(b) **(10 Marks)**

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