



Fifth Semester B.E. Degree Examination, July/August 2021 Design and Analysis of Machine Elements

Max. Marks: 100

Note: Answer any FIVE full questions.

- 1 a. Determine the safe load that can be carried by a bar of rectangular cross section as shown in Fig Q1(a). The maximum stress will be limited to 130MPa. Take stress concentration into account.

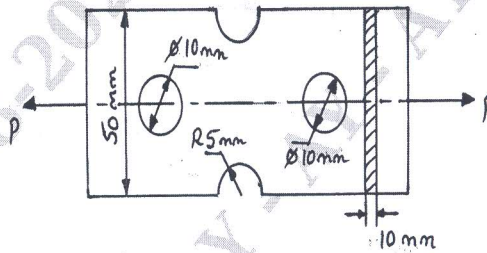


Fig Q1(a)

(10 Marks)

- b. Briefly, explain the classification of machine design. (10 Marks)

- 2 a. Determine the diameter of a round rod to sustain torsional load of 1500Nm and a bending moment of 1000Nm by the following theories of failure. Material selected for the rod has value of 300MPa and 180MPa for normal stress and shear stress at yield point respectively. Take a value of 2.5 for the factor of safety.

- i) Max shear stress theory
ii) Max distortion energy theory.

(12 Marks)

- b. Explain max normal stress theory and max shear stress theory of failure. (08 Marks)

- 3 a. A Steel rod having ultimate strength 1089.5MPa, yield strength 689.4MPa and endurance limit 427.6MPa is subjected to a tensile load which varies from 120kN to 40kN. Design the safe diameter of the rod using the "Soderberg Diagram". Adopt factor of safety as 2. Take stress concentration factor as unity and correction factors for load, size and surface as 0.75, 0.85 and 0.91 respectively. (08 Marks)

- b. A Steel member of circular section is subjected to torsional stress that varies from 0 to 35MPa and at the same time it is subjected to an axial stress that varies from -14MPa to +28MPa. Neglecting the column effect determine the factor of safety. The material has an endurance limit 206MPa and yield strength 480 MPa. Take load, size and surface correction factors as unity. (12 Marks)

- 4 a. A cantilever beam made up cold drawn carbon steel having ultimate strength of 550MPa, yield strength 470MPa and endurance limit 275MPa of circular cross-section is subjected to a load which varies from $-F$ to $3F$ as shown in Fig Q4(a). Determine the maximum load that this member can withstand for an indefinite life, using a factor of safety of 2. Take size, surface and load factors as 0.85, 0.83 and 1 respectively. Notch sensitivity factor is unity.

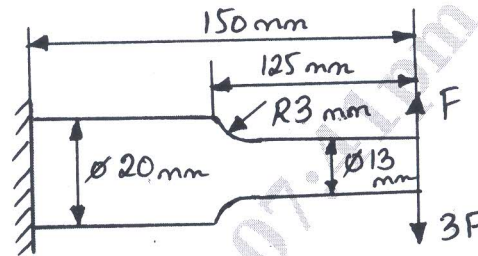


Fig Q4(a)

(10 Marks)

- b. A steel shaft is subjected to a bending moment varies from 100Nm to 200Nm and transmit 10kW at 150rpm. The torque varies over a range of $\pm 40\%$. The shaft is made of steel whose yield stress is 400N/mm^2 endurance stress is 300N/mm^2 . Take surface factor, size factor and load factor for both bending and torsion as 0.9, 1.2 and 1 respectively. Use factor of safety as 5 and stress concentration factor as 1.94. Determine the diameter of shaft for infinite life. (10 Marks)
- 5 a. Derive an expression for max shear stress induced in helical spring of circular cross section. (08 Marks)
- b. Design a helical compression spring to support an axial load of 3000N. The deflection under load is limited to 60mm. The spring index is 6. The spring is made of chrome-vanadium steel having permissible shear stress of 690MPa and modulus of rigidity of 79.34GPa. Take factor of safety as 2. (12 Marks)
- 6 a. Derive an expression for torque required to lift the load on square threaded screw. (08 Marks)
- b. A square threaded power screw has a nominal diameter of 30mm and pitch of 6mm with double threads. The load on the screw is 6kN and the mean diameter of the thrust collar is 40mm. The coefficient of friction for the screw is 0.1 and the collar is 0.09. Determine: i) Torque required to raise the screw against load ii) Torque required to lower the screw with the load iii) Overall efficiency iv) is this screw self locking. (12 Marks)
- 7 A reciprocating machine running at 360rpm is driven by 12kW, 1440rpm motor through a pair of carefully cut $14\frac{1}{2}^\circ$ involute spur gear. The Pinion is made up of heat treated cast steel of static allowable stress 193.2MPa and 450 BHN with minimum number of teeth 20. Gear is made up of untreated cast steel and static allowable stress 138.3 MPa. Assume light shock and 8 hrs per day. Check the gear for wear. Assume face width as 10 times the module. (20 Marks)
- 8 A pair of helical gears is to transmit 15kW at 5000rpm of the pinion. Both gears are made up of steel with allowable bending stress of 120MPa. The gear has to operate at centre distance of 200mm and speed reduction of 4:1. Teeth are 20° FDI and helix angle is 45° . Gears are manufactured to class III accuracy. Face width can be assumed as $16 M_n$. Determine modules, face width, number of teeth and suggest suitable hardness. (20 Marks)
- 9 a. Explain the basic steps involved in FEM with an example. (12 Marks)
- b. What are the advantages and disadvantages of FEM? (08 Marks)
- 10 a. Derive stiffness matrix for 2 noded 1D bar element. (10 Marks)
- b. Write a short note on engineering applications of FEM. (10 Marks)
