INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

B.TECH IV SEMESTER END EXAMINATIONS (REGULAR/SUPPLEMENTARY) - AUGUST 2023
Regulation: UG20
DESIGN OF MACHINE ELEMENTS

Time: 3 Hours   (MECHANICAL ENGINEERING)   Max Marks: 70

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) Demonstrate how Goodman diagram is used for fluctuating bending stresses with suitable sketch? Distinguish between fluctuating stress, repeated stress and reversed stress.

    [BL: Understand| CO: 1|Marks: 7]

   (b) A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static load consisting of bending moment 10 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using two different theories of failure, and assuming a factor of safety of 2. Take E = 210 GPa and Poisson's ratio = 0.25.

    [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) What is meant by the efficiency of the riveted joint? Explain in detail about types of riveted joints.

    [BL: Understand| CO: 2|Marks: 7]

   (b) Two plates of 10 mm thickness each are to be joined by means of a single riveted double strap butt joint. Determine the rivet diameter; rivet pitch, strap thickness and efficiency of the joint. Take the working stresses in tension and shearing as 80 MPa and 60 MPa respectively.

    [BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) With suitable diagram discuss in detail about sunk key and list the forces acting on a sunk key.

    [BL: Understand| CO: 3|Marks: 7]

   (b) Design a gib and cotter joint to carry a maximum load of 35 kN. Assuming that the gib, cotter and rod are of same material and have the following allowable stresses tensile strength= 20 MPa; shear strength= 15 MPa; and compressive strength = 50 MPa.   [BL: Apply| CO: 3|Marks: 7]

4. (a) Mention the stresses induced in the knuckle joint. Illustrate the failures of Knuckle joint in detail.

    [BL: Understand| CO: 4|Marks: 7]

   (b) Design a knuckle joint for a tie rod of a circular section to sustain a maximum pull of 70 kN. The ultimate strength of the material of the rod against tearing is 420 MPa. The ultimate tensile and shearing strength of the pin material are 510 MPa and 396 MPa respectively. Determine the tie rod section and pin section. Take factor of safety = 6.   [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Enumerate various types of stresses that are induced in shafts. Why a hollow shaft has greater strength and stiffness than solid shaft of equal weight? [BL: Understand| CO: 5|Marks: 7]

   (b) A pair of wheels of a railway wagon carries a load of 50 kN on each axle box, acting at a distance of 100 mm outside the wheel base. The gauge of the rails is 1.4 m. Find the diameter of the axle between the wheels, if the stress is not to exceed 100 MPa. [BL: Understand| CO: 5|Marks: 7]

6. (a) Describe in detail about different types of rigid couplings with suitable diagrams.

   [BL: Understand| CO: 5|Marks: 7]

   (b) Design and draw a cast iron flange coupling for a mild steel shaft transmitting 90 kW at 250 RPM. The allowable shear stress in the shaft is 40 MPa and the angle of twist is not to exceed 1° in a length of 20 diameters. The allowable shear stress in the coupling bolts is 30 MPa.

   [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Outline the various functions of a spring along the design procedure of helical compression springs under fatigue loading. [BL: Understand| CO: 6|Marks: 7]

   (b) At the bottom of a mine shaft, a group of 10 identical close coiled helical springs are set in parallel to absorb the shock caused by the falling of the cage in case of a failure. The loaded cage weighs 75 kN, while the counter weight has a weight of 15 kN. If the loaded cage falls through a height of 50 m from rest, find the maximum stress induced in each spring if it is made of 50 mm diameter steel rod. The spring index is 6 and the number of active turns in each spring is 20. Modulus if rigidity, $G = 80$ kN/mm^2. [BL: Apply| CO:6|Marks: 7]

8. (a) Summarize about types of springs and list the materials used for springs.

   [BL: Understand| CO: 6|Marks: 7]

   (b) A mechanism used in printing machinery consists of a tension spring assembled with a preload of 30 N. The wire diameter of spring is 2 mm with a spring index of 6. The spring has 18 active coils. The spring wire is hard drawn and oil tempered having following material properties:

   Design shear stress = 680 MPa

   Modulus of rigidity = 80 kN/mm^2

   Determine:

   i) The initial torsional shear stress in the wire

   ii) Spring rate

   iii) The force to cause the body of the spring to its yield strength.

   [BL: Apply| CO: 6|Marks: 7]

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