17AU53

USN ☐☐☐☐☐☐☐☐☐☐

Fifth Semester B.E. Degree Examination, June/July 2023
Design of Machine Elements – I

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.*

Module-1

1 a. Draw the stress-strain diagram for a ductile material and show salient point. **(08 Marks)**
   b. A circular rod of 60mm diameter is subjected to bending load and Torsional load as show in Fig Q1(b). Determine the nature and magnitude of stress at critical points.
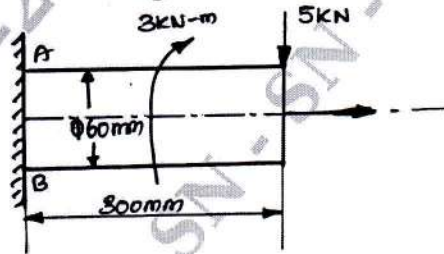

Fig Q1(b)   **(12 Marks)**

OR

2 a. Explain the following theories of failure.
      i) Maximum Normal stress theory   ii) Maximum shear stress theory. **(08 Marks)**
   b. A rod of circular section is to sustain Torsional moment of 300kN-m and Bending moment of 200kN-m selecting C-45 steel with yield stress 353N/mm² and assuming factor of safety 3 determine diameter of rod, based on following theories of failure
      i)   Maximum normal stress theory
      ii) Maximum shear stress theory
      iii) Maximum Distortion energy theory **(12 Marks)**

Module-2

3 a. Derive an expression for impact stress due to an axial load. **(08 Marks)**
   b. Determine the safe load that can be carried by a bar of rectangular cross-section shown in Fig Q3(b), limiting the maximum stress to 130 MPa taking stress concentration into account.
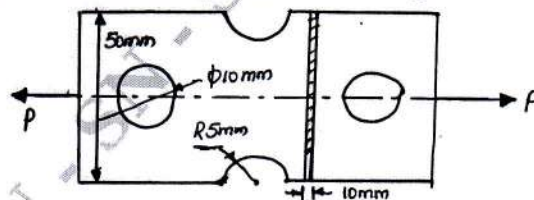

Fig Q3(b)   **(12 Marks)**

OR

4 a. Derive an expression for Soderberg equation. **(08 Marks)**
   b. A weight of 1kN is dropped from a height of 50mm at the free and of a cantilever beam of effective length 300mm. Determine the cross section of the cantilever beam of square cross section. If the allowable stress in the material of the beam is limited to 80MPa. **(12 Marks)**

Module-3

5 a. Design a socket and spigot type cotter joint to sustain an axial load of 100kN. The material selected for the joint has the following design stress. $\sigma_t = 100N/mm^2$; $\sigma_c = 150N/mm^2$ and $\tau = 60N/mm^2$. **(12 Marks)**

b. Prove that square key is equally strong in shear and compression. **(08 Marks)**

OR

6 A horizontal piece of commercial shafting is supported by two bearing 1.5m apart. A keyed gear 20° involutes and 175mm in diameter is located 400mm to the left of the right bearing and is driven by a gear directly behind it. A 600mm diameter pulley is keyed to the shaft 600mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of belt is 3 to 2, with the slack side on top. The drive transmits 45kW at 330rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflection in degrees. Use allowable shear stress 40MPa and $G = 80 \times 10^9 N/mm^2$. **(20 Marks)**

Module-4

7 a. Sketch and explain different types of Riveted joints. **(10 Marks)**

b. A double riveted lap joint is to be made between 9mm plates. It the safe working stress in Tension, crushing and shear are $80N/mm^2$, $12N/mm^2$, and $60N/mm^2$ respectively, design the riveted joint. **(10 Marks)**

OR

8 a. Sketch and explain different types of welded joints. **(10 Marks)**

b. A welded connection as shown in Fig Q8(b). If the allowable stress is $100N/mm^2$, determine the size of weld.
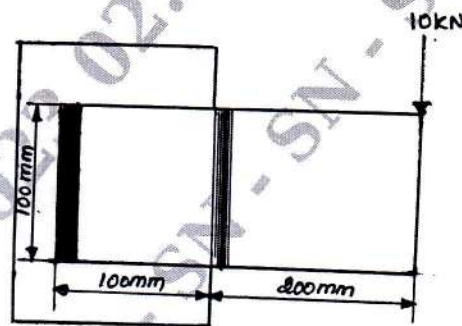

Fig Q8(b) **(10 Marks)**

Module-5

9 a. A flat circular plate used to close the flanged end of a pressure vessel of internal diameter 300mm. The vessel carrier a fluid at a pressure of $0.7N/mm^2$. A copper asbestos gasket is used to make the joint leak proof. Twelve bolts are used to faster the cover plate onto the pressure. Vessel. Find the size of bolts so that the stress in the bolts is not to exceed $100N/mm^2$ **(10 Marks)**

b. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig Q9(b). Calculate the size of the bolts if the load is 10kN and allowable shear stress in the bolt material is 40MPa.
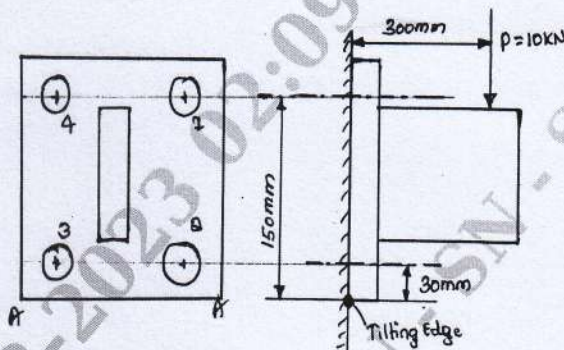

Fig Q9(b)   (10 Marks)

OR

10 a. Derive an expression for torque required to raise a load in power screws.   (10 Marks)

b. A machine slide weighing 20kN is raised by double start square threaded screw at the rate of 0.84m/min. The coefficient of friction for screw and collar is 0.12 and 0.14 respectively. The outside diameter of the screw is 44mm and pitch is 7mm. The outside and inside diameter of the cellar at the end of the screw are 58mm and 32mm respectively. Calculate the power required to drive slide. If the allowable shear stress in the screw is 30Mpa, is the screw strong enough to sustain the load.   (10 Marks)

* * * * *