Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Design of Machine Elements – I

Time: 3 hrs.   Max. Marks:100

Note: 1. *Answer FIVE full questions, selecting at least TWO questions from each part.*
        2. *Use of data hand book is permitted.*

PART – A

1   a.   Write the properties of materials.   **(06 Marks)**
     b.   List the failure of ductile and brittle materials.   **(06 Marks)**
     c.   A bar of 50 mm diameter fixed at one end is subjected to a torsional load of 1 kNm in addition to an axial pull of 15 kN. Determine the principle stresses if the length of the shaft is 250 mm.   **(08 Marks)**

2   a.   A rod of circular cross section is to sustain a torsional moment of 300 kN-m and bending moment 200 kN-m. Selecting C45 steel ($\sigma_y = 353$ MPa) and assuming FOS = 3, determine the diameter of rod as per the following theories of failure:
         (i)   Maximum shear stress theory.
         (ii)   Distortion energy theory
         (iii)   Total energy theory.   **(10 Marks)**
     b.   A weight of 1 kN is dropped from a height of 50 mm at the free end of a cantilever beam of effective length 300 mm. 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 80 MPa.   **(10 Marks)**

3   a.   Explain the SN diagram, with neat sketch.   **(06 Marks)**
     b.   A Cantilever beam shown in Fig. Q3 (b) is subjected to load variation from –F to 3F. Determine the maximum load that this member can withstand for an infinite life, using a FOS = 2, the material of the beam is SAE1025, water quenched steel ($\sigma_u = 620.8$ MPa , $\sigma_y = 400.1\,MPa$, $\sigma_{-1} = 345.2\,MPa$)   **(14 Marks)**

Fig. Q3 (b)

4   a.   Design a square key for a gear shaft of diameter 25 mm, 20 kW power at 1000 rpm is transmitted from the shaft to the gear. The yield strength of key material in tension is 450 MPa and the FOS = 3. The yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key.   **(12 Marks)**
     b.   Design a flange coupling to connect the shafts of a motor and centrifugal pump for the following specifications: Pump O/P = 3000 liters/minute,   Total head = 20 m,   Pump speed = 600 rpm, Pump efficiency = 70%,   Select C40 steel ($\sigma_y = 328.6$ MPa) for shaft and C35 steel ($\sigma_y = 304\,MPa$) for bolts with FOS = 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm^2 .   **(08 Marks)**

PART – B

5 a. List the properties of shaft material. **(05 Marks)**

   b. A horizontal piece of commercial shafting is supported by 2 bearings 1.5 m apart. A keyed gear 20° involute and 175 mm in diameter is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 to 1, with the slack side on top. The drive transmits 45 kW at 330 rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflection in degrees. Use allowable shear stress 40 MPa and $G = 80 \times 10^9$ N/mm^2. **(15 Marks)**

6 a. Explain screw thread terminology. What are its use? **(10 Marks)**

   b. The structure connection shown in Fig. Q6 (b) is subjected to an eccentric load P of 10 kN with an eccentricity of 500 mm. The centre distance between bolts 1 and 3 is 150 mm and the centre distance between 1 and 2 is 200 mm. All bolts are identical. The bolts are made of plain carbon steel having yield strength in tension of 400 MPa and the FOS is 2.5, determine the size of bolts. **(10 Marks)**
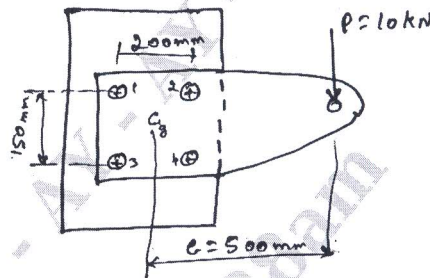
Fig. Q6 (b)

7 a. Write the types of riveted joints. Explain with neat sketch. **(06 Marks)**

   b. Design a double riveted butt joint to connect two plates 20 mm thick. The joint is zig-zag riveted and has equal width cover plates. The allowable tensile stress for the plate is 100 MPa. The allowable shear and crushing stresses for rivet material are 60 MPa and 120 MPa respectively. Calculate the efficiency of the joint. The joint should be leak proof. **(14 Marks)**

8 a. A plate of 16 mm thickness is subjected to a resultant shear stress of 75 MPa. Determine the thickness of the weld for a force of 20 KN acting @ the edge of the plate. (Fig. Q8 (a)) **(10 Marks)**
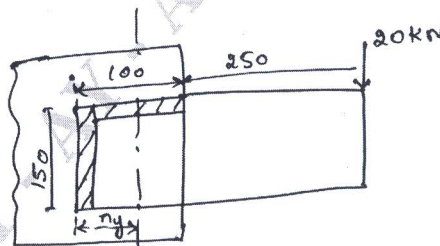

Fig. Q8 (a)

   b. The jaws of a machine vice weigh 5000 N and are slided by a two start acme thread 50 mm diameter and 8 mm pitch at a speed of 800 mm/min. The ends of the screw carried a thrust washer of mean diameter 56 mm. The coefficient of thread friction is 0.14. Determine the power of the motor required in kW and the efficiency of the drive. **(10 Marks)**

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