10ME52

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
Design of Machine Elements – I

Time: 3 hrs.   Max. Marks:100

Note: *1.Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2.Use of Data handbook is permitted.

PART – A

1   a. Write notes on :
     (i)   Ferrous materials and their properties
     (ii) Codes and Standard   **(08 Marks)**
    b. A point in a structural member subjected to plane stress is shown in Fig.Q1(b). Determine
        the following :
     (i)   Normal and tangential stress intensities on plane MN inclined at 30°.
     (ii) Principal stresses and their directions.
     (iii) Maximum shear stress and the direction of the planes on which then occur.

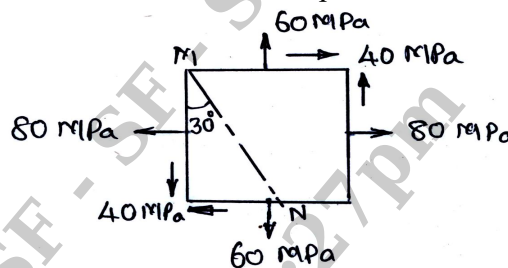Fig.Q1(b)   **(12 Marks)**

2   a. A steel shaft is subjected to a bending moment of 10 kNm and a twisting moment of
        15 kNm. The yield stress of steel is 360 MPa and Poisson's ratio is 0.3. The factor of safety
        is 2. Determine the permissible diameter of the shaft according to (i) Maximum shear stress
        theory, (ii) Maximum normal stress theory, (iii) Maximum strain theory, (iv) Maximum
        distortion theory.   **(10 Marks)**
    b. A sliding weight 1 kN falls onto a flange at the end of a vertical circular rod of length 3 m.
        The diameter of the rod is 22 mm. Assuming no loss of energy, determine the height through
        which the weight should drop in order to produce a stress in the rod of 150 MPa. Also find
        the elongation of the rod due to impact. Take E = 190 GPa.   **(10 Marks)**

3   A hot rolled steel shaft is subjected to a torsional moment that varies from 400 Nm
        clockwise to 200 Nm counter clockwise as the bending moment at the critical section varies
        from 400 Nm to – 200 Nm. Determine the diameter of the shaft for infinite life using factor
        of safety 2. The material has an ultimate strength of 550 MPa, yield strength of 440 MPa and
        the endurance limit of 275 MPa. Take the shear yield strength as $0.5\sigma_y$ and the shear
        endurance limit as $0.29\sigma_u$. The fatigue stress concentration factor for bending and torsion
        may be taken as 1.5 and 1.3 respectively.   **(20 Marks)**

4   a. A bolted joint is used to connect two components. The combined stiffness of the two
        components is twice the stiffness of the bolt. The initial lightening load on the bolt is 10 kN.
        The bolt is further subjected to an external force of 20 kN. Determine the size of the bolt if
        the allowable stress in the bolt is limited to 120 MPa.   **(08 Marks)**

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b. A bracket is bolted to a vertical support by seven bolts of equal size as shown in Fig.Q4(b). Determine the size of the bolt, if the allowable shear stress in the bolt material is 40 MPa.
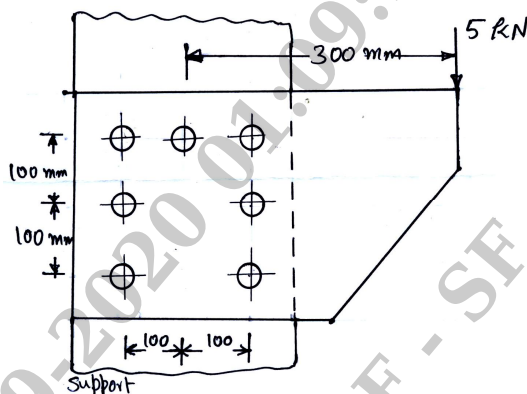

Fig.Q4(b) **(12 Marks)**

PART – B

5 A commercial steel shaft is supported on bearings 1m between centers. A cast iron pulley of 0.6m diameter weighing 1 kN is located 0.3m to the right of the right hand bearing and receives 25 kW power at 1000 rpm from a motor pulley by horizontal belt drive directly behind it. The ratio of belt tensions is 3. A 20° spur pinion of pitch circle diameter 0.2m weighing 200 N is located 0.2m to the left of the left bearing. The pinion delivers power to another gear mounted directly behind it such that the tangential force on the pinion acts vertically upwards. Assume minor shock loads on the shaft, determine the necessary diameter of the shaft if the allowable shear stress is limited to 60 MPa. **(20 Marks)**

6 a. Design a cotter joint to resist a load of 50 kN, which acts along the axes of the rods connected by a cotter. The material of the rod and cotter is the same. Take the working stresses in the material as 100 MPa in tension, 50 MPa in shear and 150 MPa in crushing.
(10 Marks)

b. Design a protective type cast iron flange coupling for steel shaft transmitting 40 kW power at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The allowable shear stress in the steel bolt and cast iron flanges are 60 MPa and 10 MPa respectively. **(10 Marks)**

7 a. Design a triple riveted butt joint with double straps of equal width longitudinal butt joint for the boiler shell of 1.5 m diameter. The maximum steam pressure is 2.6 N/mm^2. The allowable stresses in tension, shear and crushing are 124 N/mm^2, 93 N/mm^2 and 165 N/mm^2 respectively. The pitch in the outer rows in each plate is twice the pitch of rivets in the inner row. Assume that the rivets in double shear are 1.875 times stronger than in single shear and the joint efficiency as 80%. **(10 Marks)**

b. A steel plate of 10mm thick is welded to a vertical support using four sides 6mm fillet welds as shown in Fig.Q7(b). Find the safe load P if the permissible shear stress in the weld is 75 N/mm^2.
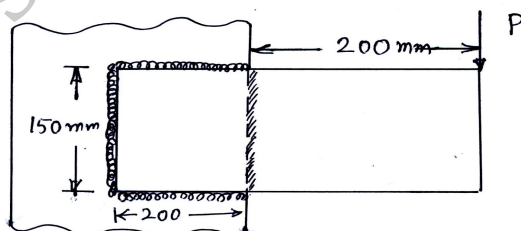

Fig.Q7(b) **(10 Marks)**

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8 a. Explain self locking screw. **(04 Marks)**

b. A machine slide weighing 12 kN is raised by a single start square treaded steel screw. The allowable stress in the material is 72.5 MPa. The mean diameter of the collar is 40mm. The nut is made of phosphor bronze having design stress of 45 MPa. The bearing pressure between the screw and the nut is 9 MPa. Determine the dimensions of screw and nut and the power required to raise the slide. The maximum speed of the slide is 0.4 m/min. **(16 Marks)**

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