USN | | | | | | | | | | |

10ME52

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 design data handbook is permitted.***

PART – A

1 a. A mild steel bracket as shown in Fig. Q1 (a) is subjected to a pull of 6000 N acting at 45° to the horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 MPa. **(10 Marks)**

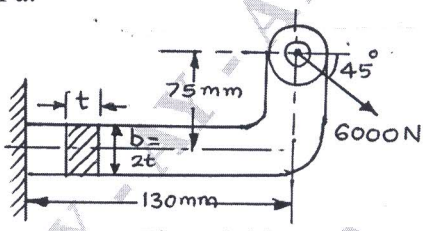

Fig. Q1 (a)

b. A point in a structural member is subjected to plane stress is shown in Fig. Q1 (b). Determine the following:
(i) Normal and tangential stress intensities on a plane inclined at 45°.
(ii) Principal stresses and their directions.
(iii) Maximum and minimum shear stresses and the direction of the plane on which they occur. **(10 Marks)**

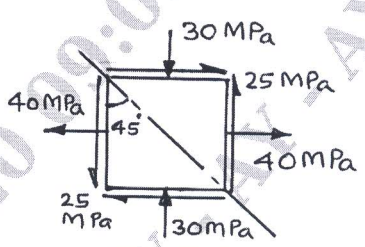

Fig. Q1 (b)

2 a. State and explain : (i) Maximum normal stress theory (ii) Distortion energy theory along with graphical representation. **(06 Marks)**

b. Find the diameter of the hole shown in Fig. Q2 (b), if the stress concentration factor at the hole is to be same as at the fillet. **(04 Marks)**

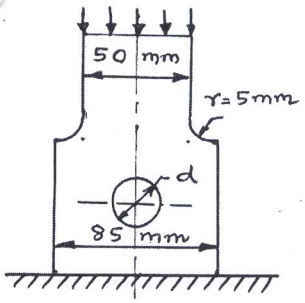

Fig. Q2 (b)

c. A weight of 20 kN falls from a height of 300 mm on a vertical steel pole of 6 meter long and 0.3 m diameter. The pole is fixed at the lower end. Take the modulus of elasticity of steel as 206 GPa. Determine : (i) Maximum compressive stress in the pole. (ii) Deformation of the pole due to impact load. (iii) Energy absorbed by the pole. **(10 Marks)**

3 a. Derive the Soderberg's equation for designing the members subjected to fatigue loading. **(08 Marks)**

b. A steel member of circular section is subjected to a torsional stress that varies from 0 to 35 MPa and at the same time it is subjected to an axial stress that varies from −14 MPa to +28 MPa. Neglecting stress concentration and column effect, and assuming that the maximum stresses in torsion and axial load occur at the same time, determine : (i) Maximum equivalent shear stress (ii) the design factor of safety based upon yield in shear. The material has an endurance limit of 206 MPa and an yield strength of $\sigma_y = 480$ MPa. The diameter of the member is less than 12 mm.

Take load correction factor = 1, surface finish factor = 1. **(12 Marks)**

4 a. A cover plate is bolted on to the flanged end of a pressure vessel through 8 bolts. The inner diameter of the pressure vessel is 250 mm and is subjected to an internal pressure of 10 MPa. Selecting the factor of safety as 2 and carbon steel C40 ($\sigma_y = 328.6$ MPa) as the material of the bolts; determine the size of the bolts, considering initial tension for the following cases : (i) metal to metal joint (ii) a copper gasket. **(10 Marks)**

b. A pulley bracket as shown in Fig. Q4 (b) is supported by 4 bolts, two at A – A and two at B – B. Determine the size of the bolts using an allowable shear stress of 25 MPa for the material of the bolts. **(10 Marks)**

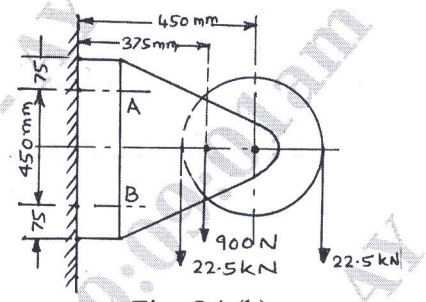

Fig. Q4 (b)

PART – B

5 A horizontal piece of commercial shafting is supported by two 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 combined shock and fatigue factor in bending and torsion are equal to 1.5. Calculate the necessary diameter of the shaft and angular deflection in degrees. Use allowable shear stress as 40 MPa and modulus of rigidity, $G = 84$ GPa. **(20 Marks)**

6 a. Design a Cotter joint to support a load varying from 30 kN in tension to 30 kN in compression. The following allowable stress may be used for the material of the joint. Tensile stress = Compressive stress = 50 MPa; Shear stress = 35 MPa and Crushing stress = 90 MPa. **(10 Marks)**

b. Design a flange coupling to connect the shafts of a motor and centrifugal pump for the following specifications:
Pump output = 3000 litres per minute ; Total head = 20 meters
Pump speed = 600 rpm ; Pump efficiency = 70 %
Select C40 steel for shaft and key, and C-35 steel for bolts with factor of safety 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm^2. **(10 Marks)**