18AU53

USN

Design of Machine Elements - I

Time: 3 hrs.   Max. Marks: 100

Note : 1. Answer any FIVE full questions.
2. Use of design data handbook is permitted
3. Missing data if any may be suitably assumed.

1 a. Explain the phases of design process.   **(05 Marks)**
   b. What is stress concentration? Mention the reasons for stress concentration. **(05 Marks)**
   c. A C – clamp shown in Fig. Q1(c) carries a load of 50kN. The cross section of the clamp is rectangular and this is made of cast steel of grade 20 – 40 with yield strength in tension is 400 MPa. Factor of safety is 4. Determine the dimension of the cross section of the clamp. Assume depth of the section is twice the width.   **(10 Marks)**

Fig. Q1(c)
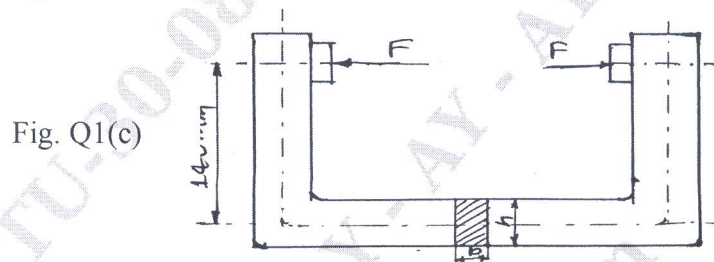
2 a. Mention the principal theories of failures and explain any three theories of failure. **(08 Marks)**
   b. A mild steel shaft of 60mm diameter is subjected to bending moment of 25×10^3 N-mm and torque M_t. If the yield stress in tension is 300N/mm². Find the maximum value of torque according to i) Maximum principal stress theory   ii) Maximum shear stress theory iii) Maximum distortion energy theory. Take FOS as 1.5.   **(12 Marks)**

3 a. An unknown weight falls through a height of 10mm on a collar rigidly attached to the lower end of the vertical bar 3m long and 600mm² in section, the maximum instantaneous extension is 2mm, what is the corresponding stress and the value of unknown weight. Take modulus of elasticity of material of bar is 200 GPa.   **(07 Marks)**
   b. A flat bar shown in Fig. Q3(b) is subjected to an axial load of 100kN. Assuming that stresses in the bar is limited to 200N/mm². Determine the thickness of the bar.   **(13 Marks)**
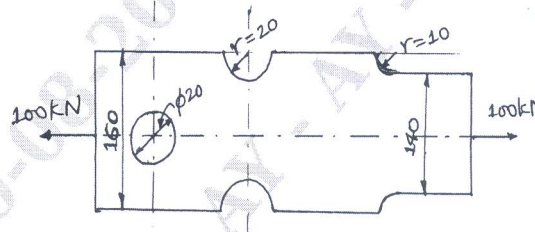

Fig. Q3(b)   All the dimensions are in mm

4 a. Derive an expression for impact stress induced in a member subjected to falling weight on a vertical bar.   **(05 Marks)**
   b. A steel member of circular cross section is subjected to a torsional stress that varies from 0-35MPa and at the same time it is subjected to an axial stress that varies from -14MPa to 28MPa. Neglecting the stress concentration and column effect and assuming that the maximum stresses in torsion and axial load occurs at the same time. Determine the maximum equivalent shear stress and the FOS based upon shear. Material has an endurance limit of 206 MPa and yield stress 408 MPa. The diameter of member is less than 12mm. Take correction factor as L, and surface finish factor as 1.   **(15 Marks)**

1 of 3

5 A horizontal commercial shaft is supported by two bearings 1.5m apart. A keyed gear 20^0 involute and 175mm 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 drive directly behind it. The ratio of tension of the belt is 3:1, with the slack side on top. The drive transmits 45kw at 330 rpm. Take $C_m(K_b) = C_t(K_t) = 1.5$. Calculate the necessary diameter of the shaft. Use allowable shear stress of 40 MPa. **(20 Marks)**

6 a. What is Cotter? Mention the different types of cotter joint. **(03 Marks)**
  b. Design a cotter joint for an axial load of 50kN which alternately changes from tensile to compressive, assuming allowable stresses in the components under tension and compression as $52.5N/mm^2$, bearing stress as $63N/mm^2$ and shearing stress as $35N/mm^2$. Sketch neatly the joint and show dimensions. **(17 Marks)**

7 a. Briefly explain the types of failure in riveted joint. **(06 Marks)**
  b. Design a double riveted butt joint with two cover plates for longitudinal beam of a boiler shell 1.5m in diameter subjected to steam pressure of $0.95N/mm^2$. Assume joint efficiency as 75% , allowable tensile stress is $90N/mm^2$, crushing stress is $140N/mm^2$ and shear stress is $56N/mm^2$. **(14 Marks)**

8 a. A bracket is welded to a side column as shown in Fig. Q8(a) with a permissible stress of $80N/mm^2$. Determine the maximum load that the bracket can withstand if the size of the weld is 10mm. **(14 Marks)**

Fig. Q8(a)
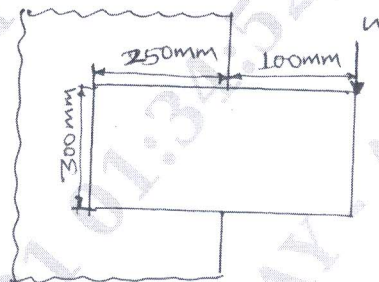
  b. A solid circular shaft 25mm in diameter is welded to a support by means of a fillet weld as shown in Fig. Q8(b). Determine the leg dimensions of the weld if the permissible shear stress is $95N/mm^2$. **(06 Marks)**

Fig. Q8(b)
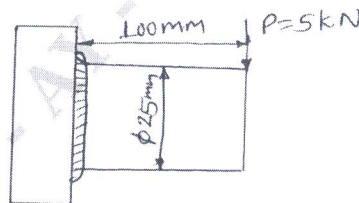
9 a. A bolted joint is used to connect two components. The combined stiffness of the two components is twice the stiffness of the bolt. The initial lightening load on the bolt is 10kN. The bolt is further subjected to an external force of 20kN. Determine the size of the bolt if the allowable stress in the bolt is limited to 120Mpa. **(08 Marks)**

b. A bracket is bolted to a vertical support by 7 bolts of equal size as shown in Fig. Q9(b). Determine the size of the bolt, if the allowable shear stress in the bolt material is 40MPa.

Fig. Q9(b)
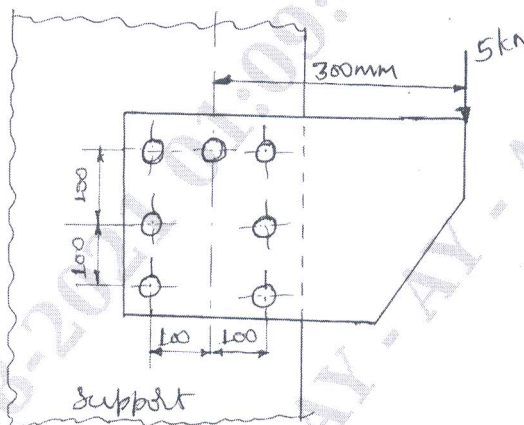
All dimensions are in mm.

(12 Marks)

10 a. Explain Self locking of screw. **(05 Marks)**

b. A machine slide weighing 12kN is raised by a single start square threaded steel screw. The allowable stress in the material is 72.5MPa. The mean diameter of the collar is 40mm. The nut is made of phosphor bronze having design stress of 45MPa. 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 load. The maximum speed of the slide is 0.4m/min. **(15 Marks)**

* * * * *