CBCS SCHEME

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

17AU53

Fifth Semester B.E. Degree Examination, Feb./Mar.2022
Design of Machine Elements – I

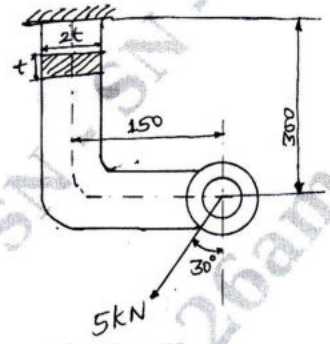
Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Missing data if any may be suitably assumed.***
3. ***Use of design data hand book is permitted.***

Module-1

1 a. Mention the steps and explain clearly design procedure. **(06 Marks)**

b. A bracket with rectangular cross section shown in Fig. Q1 (b) is subjected to a force of 5 kN acting at an angle of 30° to the vertical as shown in Fig. Q1 (b). Determine the dimensions of the bracket, taking the material as FG200 cast iron with ultimate stress, $\sigma_u = 200\ N/mm^2$ and factor of safety 3.5.



All dimensions are in mm Fig. Q1 (b) **(14 Marks)**

OR

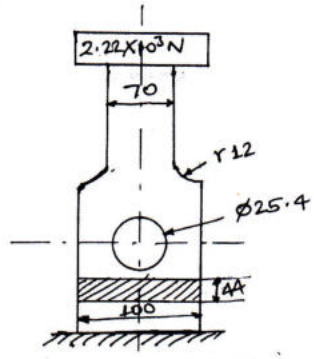
2 a. Mention and explain various, theories of failure. **(06 Marks)**

b. A mild steel shaft of 60 mm diameter is subjected to bending moment of 25×10^5 N-mm and torque 'T. If the yield stress in tension is 300 N/mm^2. 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. **(14 Marks)**

Module-2

3 a. Derive an expression for impact stress due to axial loading. **(05 Marks)**

b. Find the value of FOS of the part as shown in Fig. Q3 (b). It is made of SAE 1045 annealed steel. Find the value of FOS if the same part is made of cast iron, $\sigma_y = 310\ N/mm^2$ for SAE1045 steel and $\sigma_u = 552\ N/mm^2$ for cast iron.



All dimensions are in mm Fig. Q3 (b) **(15 Marks)**

OR

4 a. Derive an expression for Soderberg criteria. **(05 Marks)**

b. A steel member of circular cross section is subjected to a torsional stress that varies from 0 – 35 MPa and at the same time it is subjected to an axial stress that varies from -14 MPa to 28 MPa. Neglecting the stress concentration and column effect and assuming that the maximum stress in torsion and axial load occurs at the same time. Determine 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 12 mm. Take correction factor as 1 and surface finish factor as 1. **(15 Marks)**

Module-3

5 a. A square key is used to key a gear and a shaft of diameter 35 mm. The hub length of the gear is 60 mm, both key and shaft is made of same material having allowable shear stress of 55 MPa. What are the dimensions of the key according to maximum stress theory if 395 N-m of torque is to be transmitted? **(06 Marks)**

b. Design a cotter joint for the following specification. Axial thrust 100 kN. Allowable stresses are, (i) Tensile stress 100 MPa (ii) Shear stress 60 MPa
(iii) Crushing stress 120 MPa. **(14 Marks)**

OR

6 A uniform circular carbon steel shaft made of SAE 1025 annealed is mounted on two bearings 850 mm apart as shown in the Fig. Q6. The shaft carries a gear A at 200 mm to the right of the left bearing and a pulley B at 250 mm to left of the right bearing. The gear is subjected to horizontal force of 3500 N and a vertical upward force of 9600 N. The pulley is driven by a belt with a tension on tight side to be 6000 N and on the slack side to be 2000 N. The shock and fatigue factors for bending and torsion as $K_m = 2$ and $K_t = 1.5$ respectively and weight of the pulley to be 1500 N. Design the diameter of the shaft for yield stress taking factor of safety as 3. Draw neatly the sketch with loading and bending moment diagram.

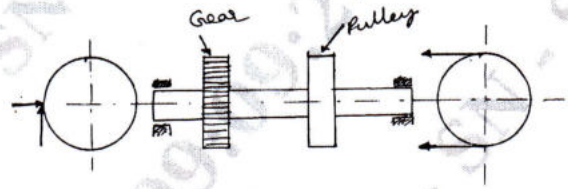


Fig. Q6 **(20 Marks)**

Module-4

7 a. A double riveted double covered butt joint 20 mm plate thickness is made with 25 mm rivet at 100 mm pitch. Permissible stresses are, $\sigma_t = 120\,N/mm^2$, $\tau = 100\ N/mm^2$, $\sigma_c = 150\ N/mm^2$. Find the efficiency of the joint. **(10 Marks)**

b. A bracket is riveted to a column by 6 rivets of equal size as shown in Fig. Q7 (b). It carries a load of 60 kN at a distance of 200 mm from the centre of the column. If the maximum shear stress in the rivet is limited to 150 N/mm^2. Determine the diameter of rivet.

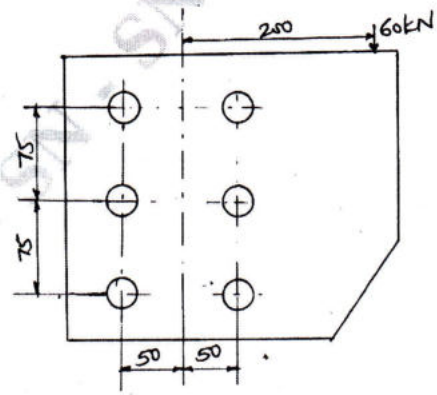
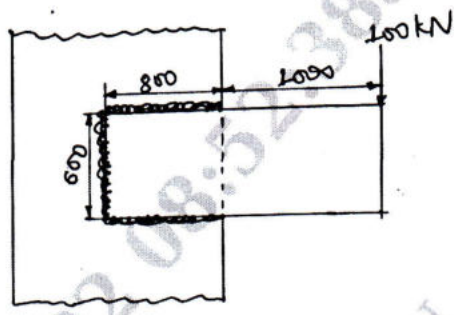


Fig. Q7 (b) **(10 Marks)**

OR

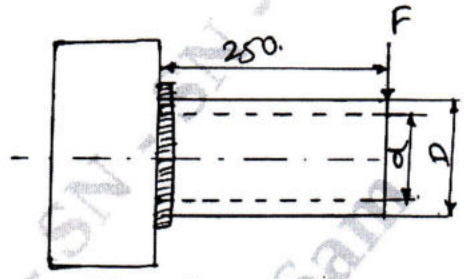
8 a. Determine the size of the fillet weld required for the flat plate loaded as shown in Fig. Q8 (a). Take allowable shear stress for the weld material as 60 MPa.



All dimensions are in mm

Fig. Q8 (a) **(10 Marks)**

b. A hollow pipe of outside diameter 100 mm and inside diameter 80 mm is welded to a column as shown in Fig. Q8 (b). Determine the size of the weld, if the stress in the weld and the pipe are to be equal, determine also the load that can be applied at the free end of the pipe assuming the stress allowable as 98 MPa.



Dimensions are in mm

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

Module-5

9 a. The structural connection shown in Fig. Q9 (a) is subjected to an eccentric load F of 10 kN with an eccentricity of 500 mm. The centre distance between bolts at 1 and 3 is 150 mm and the centre distance between bolts at 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 = 2.5. Determine the size of the bolt.

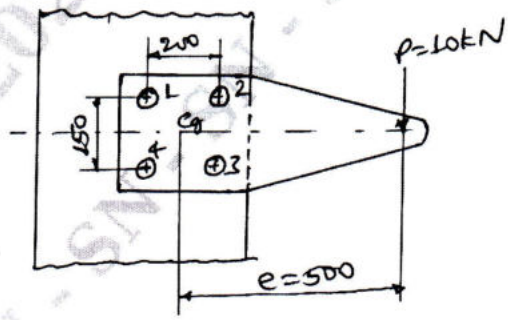


Fig. Q9 (a) **(10 Marks)**

b. A M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.55. Determine

(i) Stress in the shank of the bolt if there is no threaded portion between the nut and the bolt head.

(ii) Stress in the shank if the area of the shank is reduced to that of the root area of the thread or the entire length of bolt is threaded. **(10 Marks)**

OR

10 a. Derive an expression for torque required to raise a load on square threaded screw. **(10 Marks)**

b. A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double threads. The load as the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. The co-efficient of friction for the screw is 0.1 and the collar is 0.09. Determine

(i) Torque required to raise the screw against load.

(ii) Torque required to lower the screw with load.

(iii) Overhauling efficiency. **(10 Marks)**

* * * * *