6. a) Deduce the expression of belt tensions of flat belt drive.
   b) Derive the conditions of maximum power transmission through belt drive.

12+8=20

7. a) Differentiate between thin and thick pressure vessel. What is hoop stress?
   b) Derive the expression of tangential, radial and longitudinal stresses for thick cylinder vessel subjected to internal pressure only. Also determine the wall thickness when the cylinder material is brittle.

4+16=20



Ref. No.: Ex/Che/ES/B/Mech/T/226/2024

B.E. CHEMICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAM 2024

MACHINE DESIGN

Time: 3hrs Full Marks: 100

(Answer any five questions)
(Parts of each question must be answered together in same place)
(Do not attempt extra question, which will not be evaluated)
(Assume data if missing)

1. a) Define factor of safety in design. State in details about the factors on which the magnitude of factor of safety depends.
   b) Two rods, made of plain carbon steel 40C8 (Syt = 380 $N/mm^2$), are to be connected by means of a cotter joint. The diameter of each rod is 50 mm and the cotter is made from a steel plate of 15 mm thickness. Calculate the dimensions of the socket end making the following assumptions: (i) the yield strength in compression is twice of the tensile yield strength; and (ii) the yield strength in shear is 50% of the tensile yield strength. The factor of safety is 5.

8+12=20

2. a) How do you define yield strength for materials, which do not exhibit well-defined yield point? What is proof strength? How is it found out?
   b) It is required to design a knuckle joint to connect two circular rods subjected to an axial tensile force of 50 kN. The rods are co-axial and a small amount of angular movement between their axes is permissible. Find the

diameter of the rod, enlarged diameter of the rod, diameter of the pin, check for stresses in the eye and the fork. Assume:

On strength basis, the material for two rods and pin is selected as plain carbon steel of Grade 30C8 ($S_{yt}$ = 400 N/mm$^2$). It is further assumed that the yield strength in compression is equal to yield strength in tension.

8+12=20

3. a) Discuss the advantages and disadvantages of rigid coupling. What are the different types of misalignments? Why does misalignment exist? How it is taken care in flexible coupling?

   b) A rigid coupling is used to transmit 20 kW power at 720 rpm. There are four bolts and the pitch circle diameter of the bolts is 125 mm. The bolts are made of steel 45C8 ($S_{yt}$ = 380 N/mm$^2$) and the factor of safety is 3. Determine the diameter of the bolts. Assume that the bolts are finger tight in reamed and ground holes.

10+10=20

4. a) What is ASME Code for shaft design? What are the failure equations for square key designing?

   b) What are the assumptions in the analysis of bolted joints? The structural connection shown in Fig. 1 is subjected to an eccentric force P of 10 kN with an eccentricity of 500 mm from the CG of the bolts. The centre distance between bolts 1 and 2 is 200 mm, and the centre distance between bolts 1 and 3 is 150 mm. All the bolts are identical. The bolts are made from plain carbon steel 30C8 ($S_{yt}$ = 400 N/mm$^2$) and the factor of safety is 2.5. Determine the size of the bolts.



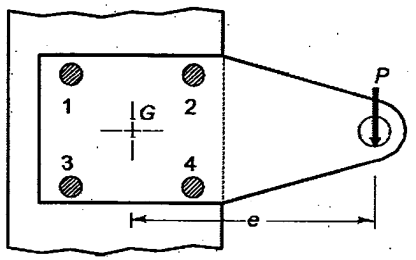


Fig. 1

8+12=20

5. a) What are the types of failure occur in riveted joints? What are Caulking and fullering? Describe the process with sketches.

   b) Two flat plates subjected to a tensile force P are connected together by means of double-strap butt joint as shown in Fig. 2. The force P is 250 kN and the width of the plate w is 200 mm. The rivets and plates are made of the same steel and the permissible stresses in tension, compression and shear are 70, 100 and 60 N/mm$^2$ respectively. Calculate: (i) the diameter of the rivets; (ii) the thickness of the plates; (iii) the dimensions of the seam, viz., p, $p_t$ and m; and (iv) the efficiency of the joint.

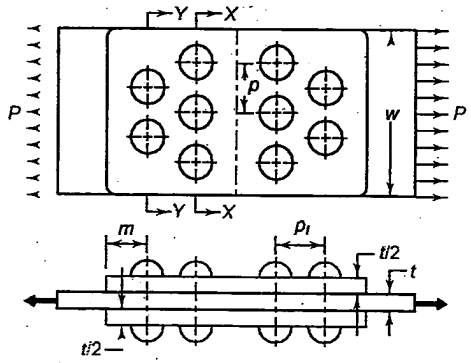


Fig. 2

10+10=20