B.E. CHEMICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAM 2023

MACHINE DESIGN

Marks: 100   Time: Three hrs

(Assume data if required)

(Answer any five)

1. a) How do you define yield strength for materials, which do not exhibit well-defined yield point?
   b) Define resilience, toughness and malleability.
   c) What is the composition of cast iron? From design consideration what are the advantages of using cast iron?
   d) What is proof strength? How is it found out?

$$5+5+5+5=20$$

2. a) Define factor of safety in design. State in details about the factors on which the magnitude of factor of safety depends.
   b) In which circumstances, higher value of factor of safety is chosen? What are the effects of higher value of factor of safety?
   c) What is uniform pressure theory? When it is used?

$$8+5+7=20$$

3. a) A rigid coupling is used to transmit 18 kW power at 700 rpm. There are four bolts and the pitch circle diameter of 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 bolts are figure tight in reamed and ground holes.
   b) Two rods are connected by means of a cotter joint. The inside diameter of the socket and outside diameter of the socket collar are 55 mm and 100 mm respectively. The rods are subjected to tensile force of 50 kN. The cotter is made of steel 30C8 (S_{yt}= 400 N/mm^2) and the factor of safety is 4. The width of the cotter is 5 times of its thickness. Calculate the width and thickness of the cotter on the basis of shear failure and bending failure.

$$10+10=20$$

OR

Two steel rods are connected by a Cotter/knuckle joint to transmit an axial load of 120 kN. Design the joint completely assuming the working stresses for the pin and rod material as 85 N/mm^2 in tensile, 70 N/mm^2 in shear and 165 N/mm^2 in crushing. Also calculate the bending stress in cotter and bearing pressure induced in eye end.

$$20$$

4. a) State the advantages of Vee thread. Draw the profile of ISO metric screw thread both internaland external in separate diagram.
   b) A flexible coupling given in the fig. 1, is used to transmit 15 kW power at 100 rpm. There are 6 pins and their pitch circle diameter is 200 mm. The effective length of the bush (l_b), the gap between both flanges and the length of the pin in contact with the right hand flange are 35, 5 and 30 mm respectively. The permissible shear and bending stresses of the pin are 35 and 150 N/mm^2 respectively. Calculate the pin diameter.
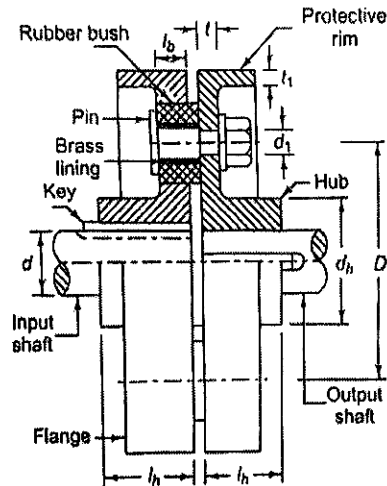
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Fig. 1

8+12=20

OR

a) Drive the expression for equivalent bending moment of shaft.

b) It is required to design a flange type coupling connecting motor and pump shafts. The power to be transmitted ..... 18 kW, speed in rev/min .....1000. Allowable stresses are as follows: 60 N/mm² as shear stress and as 110 N/mm² as crushing stress.

5+15=20

5. a) What are the assumptions in the analysis of bolted joints?Why the crest and root of Vee threads are flattened or rounded off?

b) The structural connection shown in the fig. 2, is subjected to nan eccentric force P of 10 kN with an eccentricity of 500 mm from CG of the bolts. The centre distance between bolt 1 and bolt 2 is 200 mm and the centre distance between bolt 1 and 3 is 150 mm. All the bolts are identical. The bolts are made from plain carbon steel 30C8 (S_{yt}= 400 N/mm²) and the factor of safety is 2.5. Determine the size of the bolt.
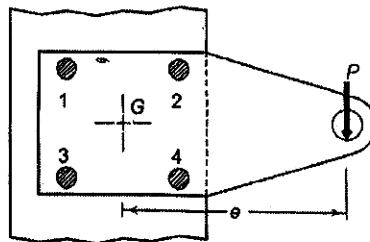

Fig. 2

8+12=20

OR

A riveted steel structure is subjected to a load of 50 kN as shown in Fig 3. Design the rivet diameter assuming allowable shear stress of the rivet material 60 N/mm².
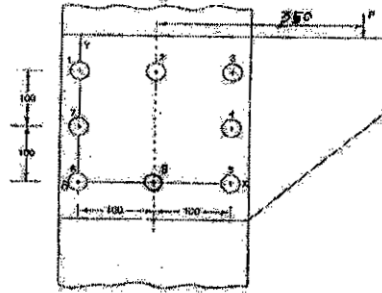
Fig. 3

20

6. For flat belt, prove: $\dfrac{p_1 - mv^2}{p_2 - -mv^2} = e^{\mu\alpha}$ all the character have usual meaning. Also find the condition for maximum power.

14+6=20

7. What are the criterions to distinguish between thin and thick cylinder? Drive the expression of radial stress in thick cylinder pressure vessel subjected to internal pressure and also deduce the Lame's equation for cylinder thickness.

3+12+5=20