

Ex/ChE/MDD/ME/T/211/2018(S)

BACHELOR OF CHEMICAL ENGINEERING SUPPLEMENTARY EXAMINATION, 2018
(2nd Year, 1st Semester, Supplementary)
MACHINE DESIGN

Time: **Three hours**

Full Marks: **100**

Missing data, if any, are to be reasonably chosen.
Give sketches wherever applicable.
Answer any **Four (4)** questions

1. a) Write down the failure modes of the main components in knuckle joint under axial loading. Draw a neat sketch of the above-mentioned joint showing various design dimensions and derive the design equations corresponding to the different types of failure for its components. [03+05+12]
 b) Which part of the knuckle joint is the weakest and why? [02]
 c) Draw a schematic representation of the stress-strain curve as obtained from standard tensile test for ductile material and show the important points on it. [03]

2. a) Design and draw a rigid (protected type) shaft coupling to transmit a rated load of 25 kW at 720 rpm. The service factor may be assumed as 1.20. Allowable shear and crushing stresses in the shaft and bolt are 38 N/mm² and 80 N/mm² respectively. Allowable shear and crushing stresses of the key are 52 N/mm² and 110 N/mm², respectively. Allowable shear stress of CI flange is 35 N/mm². [20]
 b) Discuss the function of spigot and recess as used in rigid shaft coupling. Explain the purposes of using rubber bush and brass lining in bushed-pin type flexible coupling. [02+03]

3. a) A cast iron bracket (as shown in Figure Q3(a)) supports a load of 10 kN. It is fixed to a horizontal channel by means of four bolts, two at A and two at B. The material of the fasteners is C-steel (Syt = 380 N/mm², FoS = 2.5). Determine the dimension of the fasteners. [12]

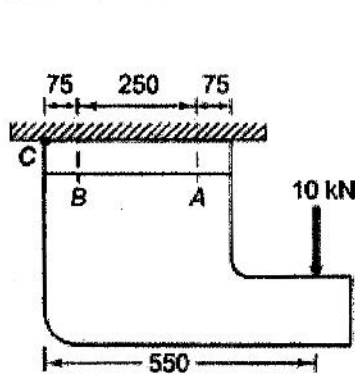


Figure Q3(a)

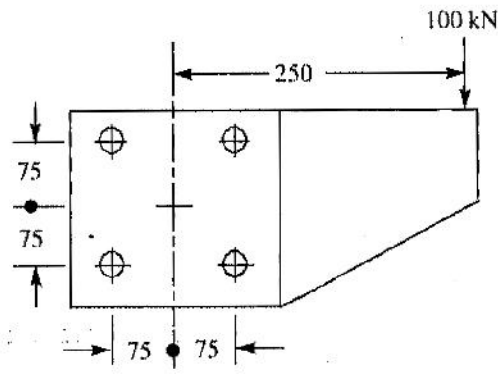


Figure Q3(b)

- b) A bracket is fixed to the wall by means of 4 identical rivets as shown in Figure Q3(b). Find out the rivet diameter considering permissible shear stress as 70 MPa. [13]

4. a) Deduce the expressions for radial, tangential and longitudinal stresses for a thick cylinder subjected to internal pressure only. Show the distribution of radial and tangential stresses across the thickness of the cylinder. [10+03]
 b) Determine the expression for cylinder wall thickness according to Clavarino and Birnie equation. [06+06]

5. (a) Write Short Notes: [04×3 = 12]
- (i). S-N Diagram
 - (ii). Stress Concentration
 - (iii). Marin's equation and factors modifying Endurance limit
- (b) A transmission shaft carries a pulley midway between two bearings. The bending moment at the pulley varies from 200 N-m to 400 N-m, as the torsional moment varies from 85 N-m to 245 N-m. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is made of steel with $S_{ut} = 520 \text{ N/mm}^2$ and $S_y = 380 \text{ N/mm}^2$. The corrected endurance limit is 210 N/mm^2 . Determine the diameter of the shaft considering a factor of safety of 2.5. [13]
6. (a) A pulley, made of grey cast iron FG 260, has four arms of elliptical cross section, in which the major axis is twice the minor axis. The tensions on tight and slack sides of the belt are 750 and 250 N respectively. The mean diameter of the pulley is 300 mm, while the hub diameter 60 mm. Assume that half number of arms transmit torque at any time. The factor of safety is 5.0. Determine the dimensions of the cross-section of the pulley arm near the hub. [10]
- (b) Derive a relation between tight side and slack side tension of a flat belt considering centrifugal effect. [10]
- (c) Discuss the importance of initial tension in belt drive? Why the slack side is preferably kept on top in horizontal flat belt drives? Why is the cross-section of the pulley arms made elliptical? [01+02+02]

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