Ex/CHE/AM/ME/T/3/2018

BACHELOR OF ENGINEERING IN CHEMICAL ENGINEERING EXAMINATION, 2018

(1st Year, 2nd Semester)

STRENGTH OF MATERIALS

Time : Three hours | Full Marks : 100

Answer any five questions

1. Answer the following questions-

   a. Clearly state the assumptions made in deriving the following relations (symbols have their usual meanings)-

   $\tau_0 = \frac{Tr_0}{J}$ and $\phi = \frac{TL}{GJ}$. [5]

   b. The electric motor exerts a 500 N-m torque on the aluminum shaft ABCD when it is rotating at a constant speed. Clearly draw the FBD of each section. Knowing that G=27GPa and that the torques exerted on pulleys B and C are as shown, determine the angle of twist between (i) B and C, (ii) B and D. [5+5+5=15]

2. Answer the following questions-

   a. Derive the expression for critical load for a fixed-fixed column. [10]

   b. Define slenderness ratio. Based on slenderness ratio how due classify columns into short, medium and long columns? What is the significance of this classification in relation to failure mode? [10]

3. Draw the shear force and bending moment diagrams for the beam configuration.

   Determine the location of point of contraflexure, if any. [15+5 = 20]

4. A bar (E = 210 GPa) of length 1.2 m tapers uniformly from a diameter of 30 mm to 18 mm. Calculate its increase in length when subjected to a tensile force of 45 kN.

   A rod of length 500 mm and diameter 25 mm is stretched by a tensile force of 10 kN at 20°C. What will be the ratio of the maximum normal and maximum shear stresses set up in the bar at 0°C, if α = 1.2 x 10-6/°C and E = 200 GPa? [10 + 10 = 20]

5. Deduce, stating assumptions, an expression for the elongation of a close-coiled helical spring subjected to axial tensile force.

[Turn over

Consider the plane stress system shown in Fig. 5, where $\sigma_x = 500$ MPa, $\sigma_y = -300$ MPa and $\tau_{xy} = 200$ MPa. Draw Mohr's circle, and mark the values of the principal stresses on the diagram. Also mention the planes on which they act. [10+10=20]

6. Derive an expression of normal bending stress, mentioning assumptions.

   A cantilever beam carries a uniformly distributed load of 10 kN/m over its entire span of 9 m. Find its maximum deflection if the flexural rigidity is 1.5×10^6 kNm^2. [10 + 10 = 20]

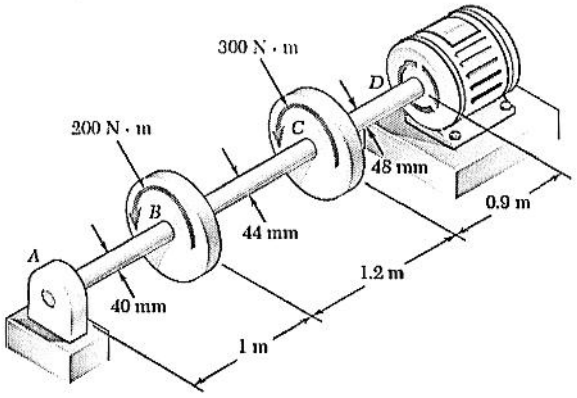
7. Write short notes on any two of the following- [10+10]

   a. By drawing the FBD of a general differential element of a beam and using equations of equilibrium show that $\frac{dM(x)}{dx} = V(x)$ and $\frac{dV(x)}{dx} = -w(x)$, where symbols have their usual meaning.

   b. Mention a failure theory applicable for brittle materials. Using that theory and with the help of Mohr's circle explain the nature of the fractured surface of a piece of chalk under torsional loading.

   c. Explain the utility of Williot diagram with an example.

   d. Show that the maximum shearing stress in a bent beam with rectangular cross-section is 50% more than the average stress.



Figure(1)

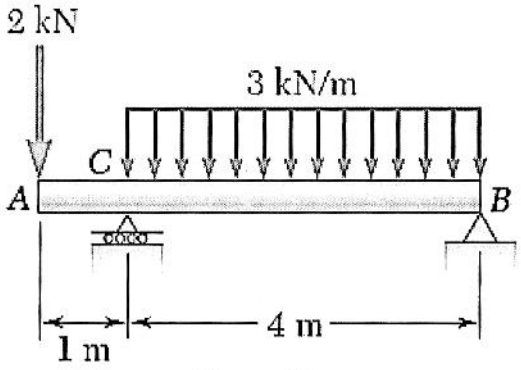


Figure (3)

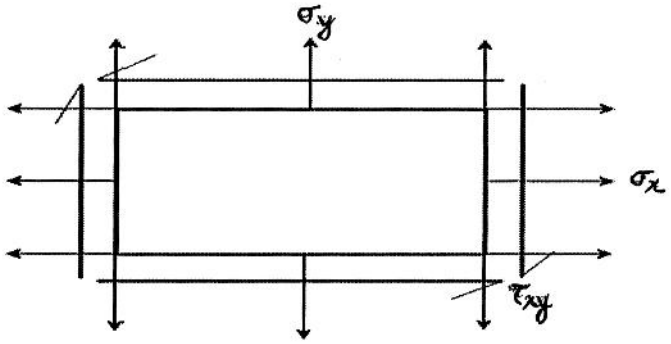


Figure (5)