Department of Civil Engineering

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Winter Semester 2023-24

End Sem Exam, 18 April 2024

Name:_____

Roll. No:_____

Sl. No:_____ S_2 $C_1/C_2/C_3/C_4$

CE1012E MECHANICS OF SOLIDS

Duration: 9.30 am to 12.30 pm Maximum Marks: [50]

Note: (a) *Answer* **all** *questions* (b) Provide neat sketches (c) Assume missing data suitably (d) Read the questions carefully

1. Determine the support reactions and the maximum shear stress in the solid shaft fixed at *A* and *B*, acted upon by torque of magnitude 30 kNm at point *C* as shown in Fig 1. Construct the torque distribution diagram. Assume G = 70 GPa. The torque direction follows the right-hand screw rule. [6]

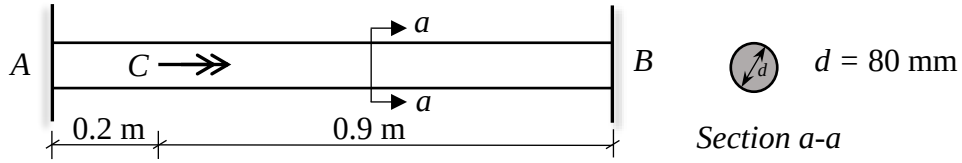
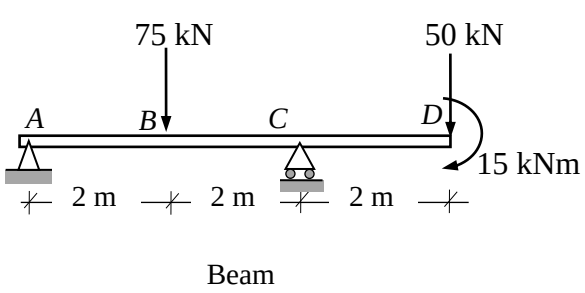


Figure 1

2. Determine the maximum bending and shear stresses in the beam shown in Fig. 2. [6]



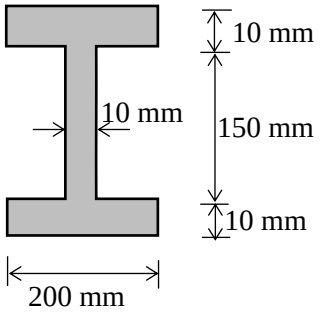


Figure 2

3. An element in an elastic body in a plane stress state has stresses given by $\sigma_x = -40$ MPa, $\sigma_y = 20$ MPa and shear stress $\tau_{xy} = 30$ MPa. (a) Determine the normal and shear stresses on a plane whose outward normal makes an angle of 40^0 counter clockwise with the x-axis. (b) Determine the principal stresses and principal planes, (c) maximum shear stress and its plane. (d) Show the answers on sketches of properly oriented elements. [10]

4. Determine the slope at *A* and deflection at *C* of the simply supported beam shown in Fig. 3 using *Macaulay's method*. Given: E = 200 GPa and $I = 4\times10^{-4}$ m^4. [10]

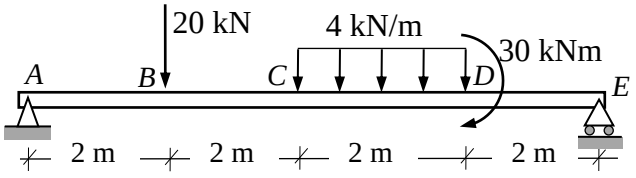


Figure 3

5. Use moment-area or conjugate beam method to determine the deflection at points *B* and *D* of the beam shown in Fig. 4. Take *EI* as constant. [10]

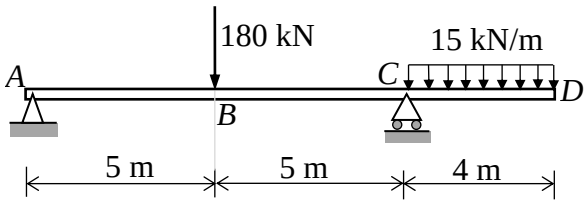


Figure 4

6. An I shaped column having properties, $A = 3080\ mm^2$, $I_{xx} = 21.1\times10^6\ mm^4$, $I_{yy} = 1.36\times10^6\ mm^4$ and $E = 200\ GPa$, is shown in Fig. 5.

   (a) Determine the maximum and minimum stress developed in the short column, if a compressive force of 200 kN acts at point *B* at a distance 50 mm from centre of gravity (point *C*) of the cross section. [6]

   (b) Calculate the critical bucking load of the column (Fig. 5), when the load acts at the centre of gravity (point *C*) and the ends are pinned. Compare the result with a column having one end fixed and the other end pinned. Draw the buckled shape of the column in both the cases. Consider the length of column as 5 m. [4]

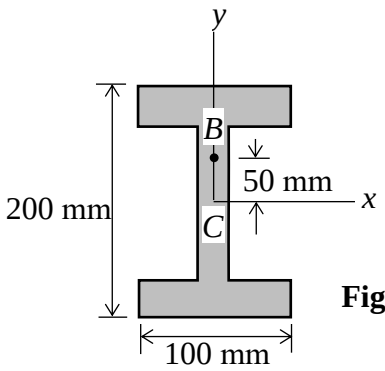


Figure 5