

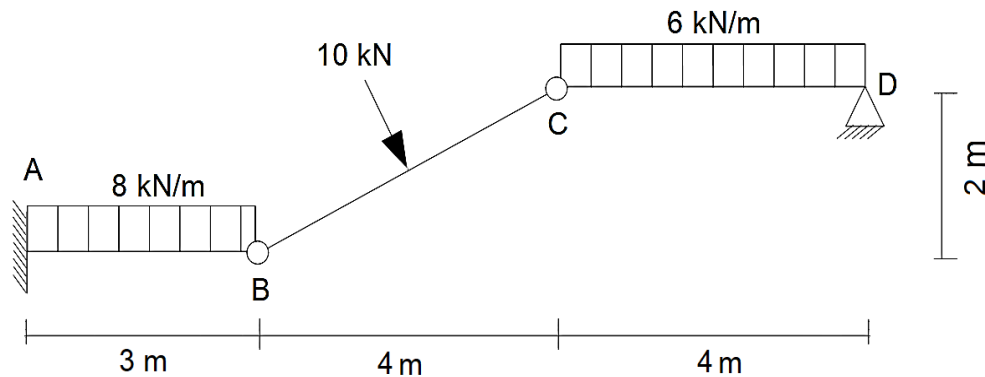
Open-book examination  
Calculators: only authorized models  
Duration : 3 hours

**16-CI-A1 Elementary Structural Analysis**

**Question 1 (25%)**

For the structure ABCD shown on Figure 1, calculate all support reactions and the internal forces  $N$  and  $V$  transmitted at joint B.

Also, draw the normal, shear force and bending moment diagrams for ABCD. For each diagram, calculate and indicate the magnitudes of the maximum positive and negative ordinates and the longitudinal coordinates where they occur. Note that joints B and C are hinges.

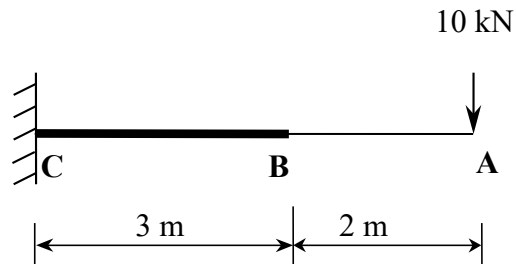


**Figure 1**

**Question 2 (25%)**

Calculate the rotation and the vertical displacement at point A of the beam CBA shown on Figure 2. Take  $I_{AB} = 75 \cdot 10^6 \text{ mm}^4$ ,  $I_{BC} = 150 \cdot 10^6 \text{ mm}^4$  et  $E = 200 \text{ GPa}$ .

Use the moment area method.



**Figure 2**

### Question 3 (25%)

For the indeterminate truss shown on Figure 3, determine the axial forces in all members by using the method of virtual work. Assume that  $EA$  is the same constant for all members.

Note: Consider  $CD$  as the redundant member.

$$E = 200 \text{ GPa}, A = 241.94 \text{ mm}^2$$

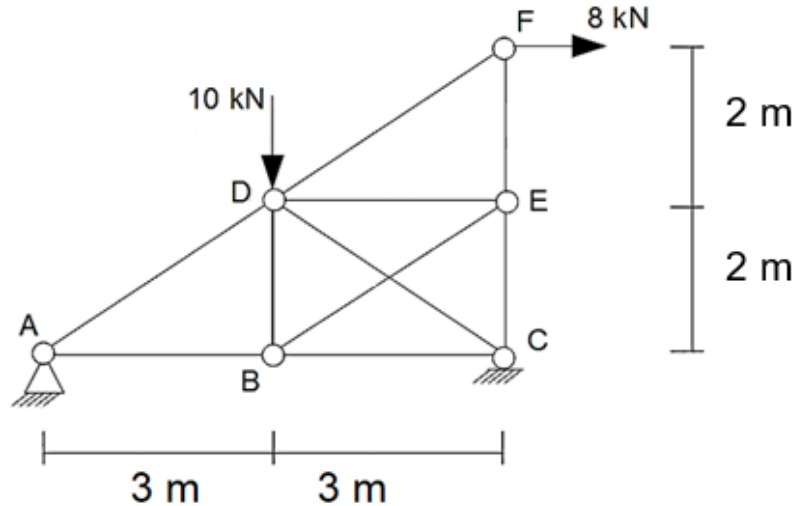


Figure 3

### Question 4 (25%)

For the indeterminate beam ABCD shown on Figure 4, support B settles downward by 10 mm, and support A undergoes a counter-clockwise rotation of  $1/50$  radian. Use the slope deflection method to:

1. Determine the rotations at B and C;
2. Determine the moments of continuity;
3. Calculate support reactions and plot DCL for each element;

$$\text{Consider } EI = 1500 \text{ kN.m}^2$$

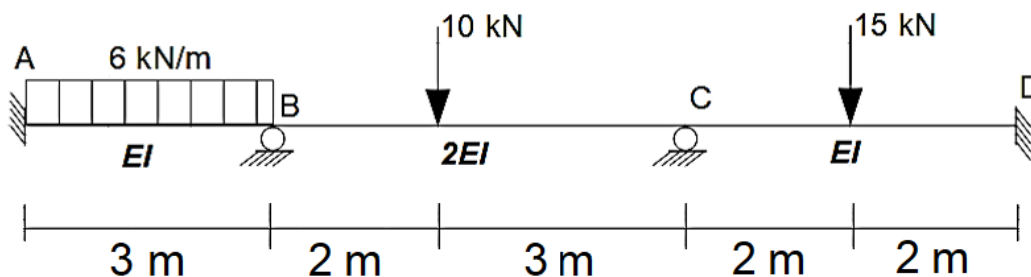


Figure 4