Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Student number\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Assignment 3**

*L*

1

1

3

2

*Y*

*Z*

3

2

*F*

*L*

The structure shown consists of three elastic bars connected by joints and a point force acting on node 3. Young’s modulus of the material is . The cross-sectional area of bars 1 and 3 is and that for bar 2 . Determine the displacement components and .

**Solution template**

Virtual work expression of the bar element is of the form

.

In the problem, the structure is loaded only by the point force so . To express the axial components (in the virtual work expression above) in terms of those in the structural coordinate system, one has to assign a material coordinate system to each bar element.

For element 1, let the axis be aligned from node 1 to 3. In terms of displacement components in the structural system, the displacement components in the direction of the bar axis are

 and .

In terms of displacement components in the structural system, element 1 contribution takes the form

.

For element 2, let the axis be aligned from node 2 to 1. In terms of displacement components in the structural system, the displacement components in the direction of the bar axis are

 and .

In terms of displacement components in the structural system, element 2 contribution takes the form

.

For element 3, let the axis be aligned from node 2 to 3. In terms of displacement components in the structural system, the displacement components in the direction of the bar axis are

 and .

In terms of displacement components in the structural system, element 3 contribution takes the form

.

Virtual work expression of a point force (taken as element 4) follows from the definition of work

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Virtual work expression of the structureis sum of the element contributions

.

Principle of virtual work  and the fundamental lemma of variation calculus in the form imply

 . **🡸**