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

**Assignment 1**

Derive the virtual work expression for the bar element (planar problem) shown in terms of nodal displacement components of the structural system.



*Z, y*

*Y, x*

2

1



**Solution template**

Virtual work expressions of the bar model according to the large displacement theory are

 in which ,

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In the expressions,  and are the cross-sectional area and length of bar at the initial geometry,  are the components of the distributed body force (force per unit volume), and , *C* are the density and elasticity parameter of the material. The squared length of the deformed bar



depends on the nodal displacements.

Let us start with the displacement components of the material coordinate system in terms of those of the structural system and the body force components

, , ,

, , ,

,  , .

Length of the deformed bar squared is given by

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Therefore, the Green-Lagrange strain measure and its variation take the forms

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Using the quantities above, virtual work expressions of the internal and external forces simplify to

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