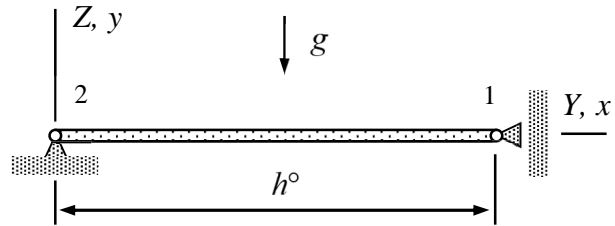


Name _____ Student number _____

Assignment 2

Derive the virtual work expressions for the element shown in terms of the nodal displacement components of the structural system. Use linear approximations to the displacement components. Cross-sectional area and density of the initial geometry are A° and ρ° , respectively, and elasticity parameter C .



Solution template

Virtual work densities of the bar model according to the large displacement theory are given by

$$\delta w_{\Omega^\circ}^{\text{int}} = -\delta E_{xx} C A^\circ E_{xx}, \quad \delta w_{\Omega^\circ}^{\text{ext}} = \rho^\circ A^\circ (\delta u g_x + \delta v g_y + \delta w g_z)$$

in which the Green-Lagrange strain measure and its variation

$$E_{xx} = \frac{du}{dx} + \frac{1}{2} \left(\frac{du}{dx} \right)^2 + \frac{1}{2} \left(\frac{dv}{dx} \right)^2 + \frac{1}{2} \left(\frac{dw}{dx} \right)^2, \quad \delta E_{xx} = \frac{d\delta u}{dx} + \frac{d\delta u}{dx} \frac{du}{dx} + \frac{d\delta v}{dx} \frac{dv}{dx} + \frac{d\delta w}{dx} \frac{dw}{dx}.$$

Linear approximations to displacement components in terms of nodal displacement components of the structural system and the body force components are given by

$$u = \underline{\hspace{2cm}}, \quad v = \underline{\hspace{2cm}}, \quad w = \underline{\hspace{2cm}},$$

$$g_x = \underline{\hspace{2cm}}, \quad g_y = \underline{\hspace{2cm}}, \quad g_z = \underline{\hspace{2cm}}.$$

Green-Lagrange strain measure and its variation in terms of displacement components of the structural system are

$$E_{xx} = \underline{\hspace{2cm}}, \quad \delta E_{xx} = \underline{\hspace{2cm}}.$$

Virtual work densities of internal and external distributed forces

$$\delta w_{\Omega^\circ}^{\text{int}} = \underline{\hspace{2cm}},$$

$$\delta w_{\Omega^\circ}^{\text{ext}} = \underline{\hspace{2cm}}.$$

Finally, virtual work expressions are integrals over the initial domain

$$\delta W^{\text{int}} = \int_0^{h^\circ} \delta w_{\Omega^\circ}^{\text{int}} dx = \underline{\hspace{10cm}}, \quad \leftarrow$$

$$\delta W^{\text{ext}} = \int_0^{h^\circ} \delta w_{\Omega^\circ}^{\text{ext}} dx = \underline{\hspace{10cm}}. \quad \leftarrow$$