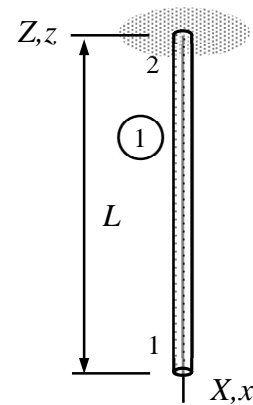


Name _____ Student number _____

Assignment 1

Determine the displacement of node 1 of the bar structure shown at the constant temperature ϑ° . Use a linear approximation and assume that parameters E , A and α are constants. At the initial temperature $2\vartheta^\circ$, length of the bar is L and stress in the bar vanishes.



Solution template

In stationary thermo-elasticity without external forces, the virtual work density of the bar model is given by

$$\delta w_\Omega = -\frac{d\delta u}{dx} EA \frac{du}{dx} + \frac{d\delta u}{dx} EA \alpha \Delta \vartheta.$$

Linear interpolants to axial displacement $u(x)$ and temperature change $\Delta \vartheta(x)$ are

$$u(x) = \frac{x}{L} u_{X1},$$

$$\Delta \vartheta(x) = \vartheta^\circ - 2\vartheta^\circ = -\vartheta^\circ.$$

When $u(x)$ and $\Delta \vartheta(x)$ are substituted there, virtual work density simplifies to

$$\delta w_\Omega = \underline{\hspace{2cm}}.$$

Integration over the element gives

$$\delta W = -\delta u_{X1}(\underline{\hspace{2cm}}).$$

Principle of virtual work $\delta W = 0 \quad \forall \delta \mathbf{a}$ and the fundamental lemma of variation calculus imply the nodal displacement

$$u_{X1} = \underline{\hspace{2cm}}. \quad \leftarrow$$