Problem 5. A linearly elastic beam has a square cross-section (width b, height h, area A). Length of the beam is L. Only a shear force $V_y(x)$ in the direction of the y-axis is applied to the beam. This means that the only non-zero stress component is τ_{xy} and the strain energy density can be written as

$$U_0 = \tau_{xy}\epsilon_{xy} = \frac{\tau_{xy}^2}{2G}. \tag{1}$$

Show that using the shown strain energy density the following can be derived

$$U = \frac{\alpha}{2}\int_0^L \frac{V_y^2(x)}{GA}dx. \tag{2}$$

(6p)