

6.18 This problem asks that we calculate the modulus of elasticity of a metal that is stressed in tension. Combining Equations 6.5 and 6.1 leads to

$$E = \frac{\sigma}{\varepsilon_z} = \frac{F}{A_0 \varepsilon_z} = \frac{F}{\varepsilon_z \pi \left(\frac{d_0}{2}\right)^2} = \frac{4F}{\varepsilon_z \pi d_0^2}$$

From the definition of Poisson's ratio, (Equation 6.8) and realizing that for the transverse strain, $\varepsilon_x = \frac{\Delta d}{d_0}$

$$\varepsilon_z = -\frac{\varepsilon_x}{\nu} = -\frac{\Delta d}{d_0 \nu}$$

Therefore, substitution of this expression for ε_z into the above equation yields

$$\begin{aligned} E &= \frac{4F}{\varepsilon_z \pi d_0^2} = \frac{4F \nu}{\pi d_0 \Delta d} \\ &= \frac{(4)(1500 \text{ N})(0.35)}{\pi (10 \times 10^{-3} \text{ m})(6.7 \times 10^{-7} \text{ m})} = 10^{11} \text{ Pa} = 100 \text{ GPa} \quad (14.7 \times 10^6 \text{ psi}) \end{aligned}$$