54. Determine the input impedance $\mathbf{Z}_{in}(s)$ seen looking into the terminals of the network depicted in **Fig. 14.52**. Express your answer as a ratio of two s-polynomials.

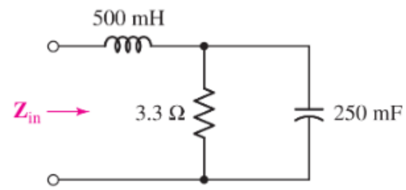

FIGURE 14.52

$$Z_{in} = sL + R \parallel \frac{1}{sC}$$

$$= sL + \frac{R}{1+sRC}$$

$$= \frac{sL + s^2LCR}{1+sRC} + \frac{R}{1+sRC}$$

$$= \frac{s^2LCR + sL + R}{1+sRC}$$

Double-check:

at low frequency, $L \to$ short, $C \to$ open, so $Z_{in} \to R$

as $s \to 0$, $\lim_{s\to 0} \frac{s^2LCR + sL + R}{1+sRC} = R$ ✓

at high frequency, $C \to$ short, $L \to$ open, so $Z_{in} \to sL$

as $s \to \infty$ $\lim_{s\to\infty} \frac{s^2LCR + sL + R}{1+sRC} = \lim_{s\to\infty} \frac{s^2LCR}{sRC} = sL$ ✓

Plugging in

$$Z_{in}(s) = \frac{0.4125s^2 + 0.5s + 3.3}{1 + 0.825s}$$