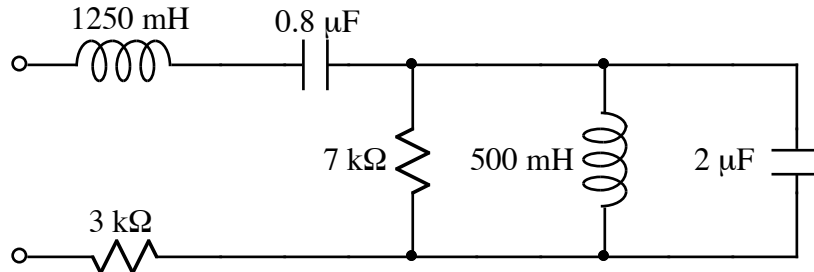


Ex: Find the total impedance of the circuitry shown below if $\omega = 50\text{k rad/s}$.



SOL'N: We convert to the frequency-domain by computing impedances.

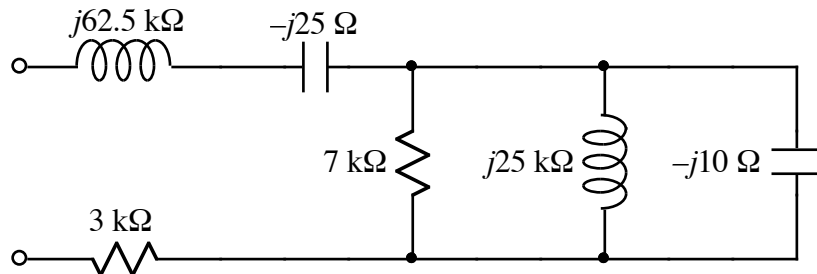
$$j\omega L = j50\text{k} \cdot 1250\text{m} \Omega = j62.5 \text{ k}\Omega$$

$$\frac{1}{j\omega C} = \frac{1}{j50\text{k} \cdot 0.8\mu} \Omega = -j25 \Omega$$

$$j\omega L = j50\text{k} \cdot 500\text{m} \Omega = j25 \text{ k}\Omega$$

$$\frac{1}{j\omega C} = \frac{1}{j50\text{k} \cdot 2\mu} \Omega = -j10 \Omega$$

The circuit diagram in the frequency-domain is shown below.



The series L and C in series at the top left have dramatically different impedance values. The capacitor's impedance is so small that it may be ignored when added to the impedance of the inductor. (We may generally ignore values that affect only the fourth significant digit.) Even if we use the exact value of the sum of the impedances of the top left L and C , the extra information will be lost when we round off our final answer to three significant digits.

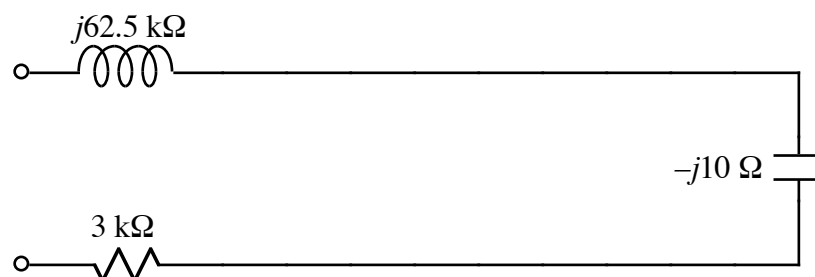
We move on to the parallel impedances. It is usually easier to compute the parallel reactive (purely imaginary) impedances first, rather than mixing resistive and reactive impedances. Once again, however, the L and

C have dramatically different impedance values. For impedances in parallel, the much larger impedance may be ignored. This becomes apparent from the computation of the exact value of the parallel impedance:

$$j25 \text{ k}\Omega \parallel -j10 \text{ }\Omega = j5 \text{ }\Omega \cdot 5 \text{ k} \parallel -2 = j5 \text{ }\Omega \cdot \frac{5 \text{ k}(-2)}{5 \text{ k} - 2} \approx j5 \frac{-10 \text{ k}}{5 \text{ k}} \text{ }\Omega \approx -j10 \text{ }\Omega$$

Our conclusion is that the 500 mH inductor may be ignored. This leaves the 7 k Ω resistor in parallel with $-j10 \text{ }\Omega$. Although these impedances differ by being purely real in one case and purely imaginary in the other case, they may still be treated in a similar fashion to parallel values of the same type when determining whether one is so large that it may be ignored. Here, the 7 k Ω resistance is much larger than the $-j10 \text{ }\Omega$ impedance and may be ignored. To see why this would be true, we may think of the impedances as vectors. When one vector is much longer (larger magnitude) than the other, that vector dominates the sum. (For parallel impedances, the vectors we add are the conductances, which are equal to the inverses of the impedances. A small impedance yields a large conductance.)

Based on the above discussion, we conclude that we may ignore the 7 k Ω resistance. (Actually, we are stretching the rules by ignoring the parallel resistance, as the values in question differ by less than a factor of 1000. We will discover, however, that even the final parallel impedance value may be ignored. The lesson here is that it may be worthwhile to try an approximation at one stage to see what it leads to later on. It is always possible to return to the earlier approximation and correct it, if necessary. This leaves us with the circuit shown below:



As stated above, we see that the $-j10 \Omega$ resistance is tiny compared to the impedance of the inductance. Thus, we ignore the capacitor. The resistance is larger than one percent of the impedance of the inductor, so we retain it in our final answer:

$$z_{\text{tot}} = 3 \text{ k} + j62.5 \text{ k } \Omega$$