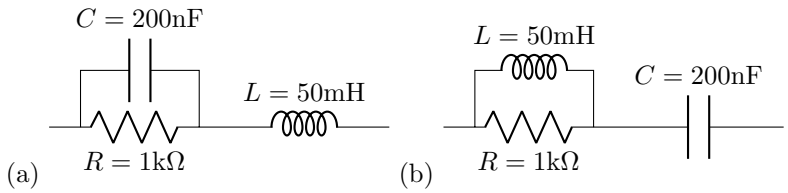
Physics 2250: Problem Set IX

Jeremy Favro

December 2, 2024

Problem 1. Determine both the DC impedance and the impedance at a frequency of $f = 1\text{kHz}$ of the circuits shown below.



Solution 1.

(a)

$$\begin{aligned}
Z &= \left(\frac{1}{R} + j\omega C\right)^{-1} + j\omega L \\
&= \frac{R}{1 + j\omega CR} + j\omega L \\
&= \frac{R + (j\omega L)(1 + j\omega CR)}{1 + j\omega CR} \\
&= \frac{R(1 - j\omega CR) + (j\omega L)\left(1 + (\omega CR)^2\right)}{1 + (\omega CR)^2} \\
&= \frac{R - j\omega CR^2 + j\omega L + j\omega L(\omega CR)^2}{1 + (\omega CR)^2} \\
&= \frac{R}{1 + (\omega CR)^2} + \frac{-\omega CR^2 + \omega L + \omega L(\omega CR)^2}{1 + (\omega CR)^2} j
\end{aligned}$$

Which means that the DC impedance ($\omega = 0$) is just R, and impedance with a frequency of 1kHz is $\frac{12500}{13} - \frac{1850}{13} j$