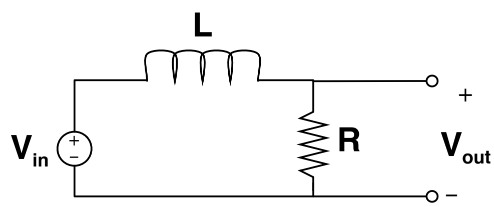
1. Proof of Induction

Given the voltage-current relationship of an inductor $V = L\frac{di}{dt}$, show that its complex impedance is $Z_L = j\omega L$.

2. L-R Filter

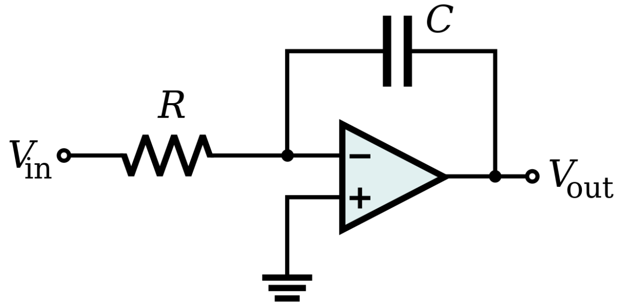


(a) Write the frequency response function $H(\omega) = \frac{V_{out}}{V_{in}}$ for the circuit.

(b) If $R = 10\Omega$ and $L = 100\text{mH}$, plot the log-magnitude of $H(\omega)$ and label important magnitudes and frequencies.

(c) If $V_{in}(t) = \cos(10t) + \cos(100t) + \cos(1000t)$, what is $V_{out}(t)$? (Assume that $H(-\omega) = H(\omega)$.)
Caveat: We have not yet discussed how the *phase* of V_{in} is affected by the circuit. Ignore this for now; assume the phase of the output is the same as the phase of the input.

3. Op-Amps: What *Can't* They Do?



(a) Write the frequency response function $H(\omega) = \frac{V_{out}}{V_{in}}$ for the circuit.

(b) If $R = 1\text{k}\Omega$ and $C = 100\text{nF}$, plot the log-magnitude of $H(\omega)$ and label important magnitudes and frequencies. (Again assume that $H(-\omega) = H(\omega)$.)

(c) **Challenge:** What does this circuit do?
Hint: You will probably need to set up the differential equation relating V_{out} and V_{in} to work this out.