Exercise 1. Average Voltage

If the voltage is $V(t) = V_0 \sin(\omega t)$, what is the average voltage?

(a) $V_{\text{avg}} = 4V_0/\omega$
(b) $V_{\text{avg}} = 2V_0/\pi$ *
(c) $V_{\text{avg}} = V_0/\sqrt{2}$
(d) $V_{\text{avg}} = 4V_0 \sin(\omega t)/\omega$
(e) $V_{\text{avg}} = 2V_0 \sin(\omega t)/\pi$
(f) $V_{\text{avg}} = V_0 \sin(\omega t)/\sqrt{2}$

Exercise 2. RMS Voltage

If the voltage is $V(t) = V_0 \sin(\omega t)$, what is the RMS voltage?

(a) $V_{\text{rms}} = 4V_0/\omega$
(b) $V_{\text{rms}} = 2V_0/\pi$
(c) $V_{\text{rms}} = V_0/\sqrt{2}$ *
(d) $V_{\text{rms}} = 4V_0 \sin(\omega t)/\omega$
(e) $V_{\text{rms}} = 2V_0 \sin(\omega t)/\pi$
(f) $V_{\text{rms}} = V_0 \sin(\omega t)/\sqrt{2}$

Exercise 3. RMS Power

If $P_{\text{rms}} = \sqrt{\int_T dt\ P^2(t)/T}$, and $P = IV$ where $I(t) = I_0 \cos(\omega t)$ and $V = V_0 \cos(\omega t + \theta)$, show that $P_{\text{avg}} = I_0 V_0 \cos(\theta)/2$. Hint: $\cos(\alpha + \beta) = \cos(\alpha)\cos(\beta) - \sin(\alpha)\sin(\beta)$.

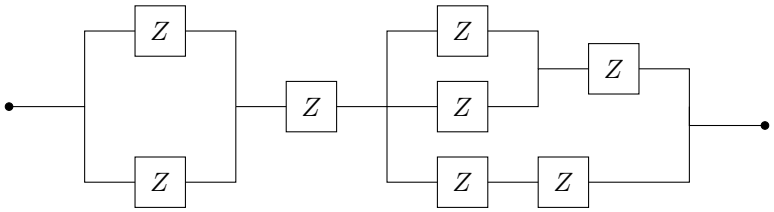
Exercise 4. Phase Angle

Let $f(t) = (1 - \sin(t)/t) + 2i$. What is the phase angle for large times?

(a) $\theta(f(t)) = \tan^{-1}(2)$ *
(b) $\theta(f(t)) = \tan^{-1}(\pi/2)$
(c) $\theta(f(t)) = \tan^{-1}(1/2)$
(d) $\theta(f(t)) = \tan^{-1}(2/\pi)$

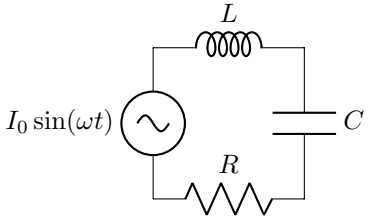
Exercise 5. Equivalent Impedance

Find the equivalent impedance of the following circuit:



Exercise 6. Resonance I

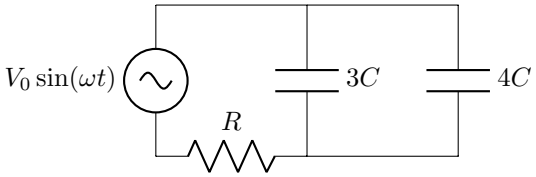
Resonance occurs when impedance is at its minimum. Find ω such that the impedance is minimized in the following circuit:



Exercise 7. Resonance II

Find the phase angles $\theta(V_L(t))$, $\theta(V_C(t))$ and $\theta(V_R(t))$ for the circuit when driven at the resonance frequency.

Exercise 8. Impedant Circuit I



What is the equivalent impedance of the circuit above as measured across the voltage source? What is $|Z|$?

Exercise 9. Impedant Circuit II

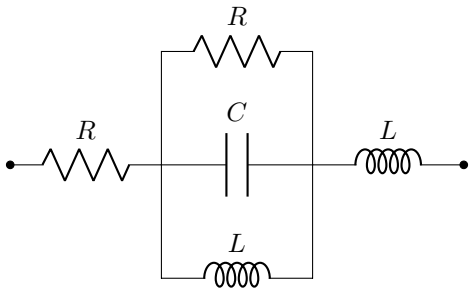
Find $V_R(t)$ and $V_{3C}(t)$. Does $V_{3C}(t) = V_{4C}(t)$?

Exercise 10. Impedant Circuit III

Find $\theta(V_R(t))$ and $\theta(V_{3C}(t))$, what is the phase difference. Is it constant?

Exercise 11. Resonance Again

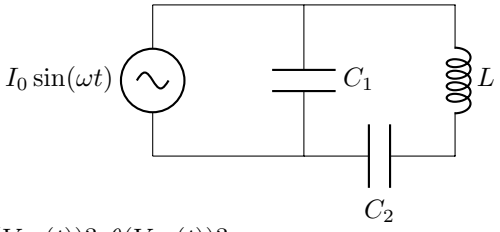
Consider the circuit below:



Express the impedance of this circuit in the form $Z_{\text{circuit}} = a + bi$ for real numbers a and b. If $C = 0$, what is the resonance frequency of the circuit?

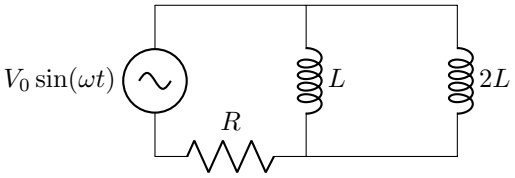
Exercise 12. Another Circuit

Consider the circuit below:



Supposing that $C_1 = C_2 = C$, what is $\theta(V_{C_1}(t))$? $\theta(V_{C_2}(t))$?

Exercise 13. Equivalent Circuits I



Convert the circuit above into an equivalent circuit with one resistor, R', and one inductor, L'. Explain why the phase angle in this equivalent circuit are the same as the phase angles in the original circuit.

Exercise 14. Equivalent Circuits II

Using the equivalent circuit from the last problem, find the phase angles $\theta(V_R) = \theta(V_{R'})$ and $\theta(V_L) = \theta(V_{L'})$.