# Homework 1

**This homework is due on Friday, September 2, 2022, at 11:59PM. Self-grades and HW Resubmissions are due on the following Friday, September 9, 2022, at 11:59PM.**

1. **Hambley P3.7**

   A constant (dc) current $i(t) = 3\,\text{mA}$ flows into a $50\,\mu\text{F}$ capacitor. The voltage at $t = 0$ is $v(0) = -20\,\text{V}$. The references for $v(t)$ and $i(t)$ have the passive configuration. Find the power at $t = 0$ and state whether the power flow is into or out of the capacitor. Repeat for $t = 1$.

**2. Hambley P3.16**

A capacitance and the current through it are shown in Figure 1 and Figure 2 respectively. At $t = 0$, the voltage is $v_C(0) = 10\,\text{V}$. Sketch the voltage, power, and stored energy to scale versus time.

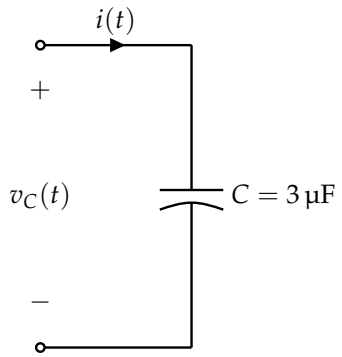


**Figure 1:** Circuit for P3.16

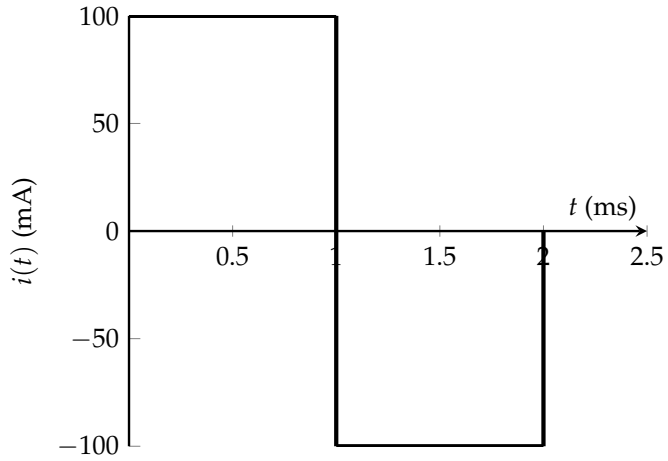


**Figure 2:** Current vs Time for P3.16

**3. Hambley P3.34**

We have a parallel-plate capacitor, with each plate having a width $w$ and a length $\ell$. The plates are separated by air with a distance $d$. Assume that $\ell$ and $w$ are both much larger than $d$. The maximum voltage that can be applied is limited to $V_{\max} = Kd$, in which $K$ is called the breakdown strength of the dielectric. Derive an expression for the maximum energy that can be stored in the capacitor in terms of $K$ and the volume of the dielectric. If we want to store the maximum energy per unit volume, does it matter what values are chosen for $\ell$, $w$, and $d$? What parameters are important?

**4. Hambley P3.43**

The current flowing through a 2 H inductance is shown in Figure 3. Sketch the voltage, power, and stored energy vs time.

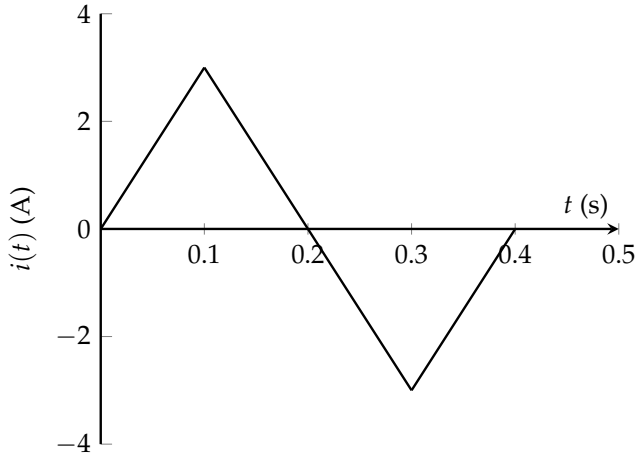


**Figure 3:** Current vs Time for P3.43

**5. Hambley P3.7**

The current in a 100 mH inductance is given by $0.5\sin(1000t)$A. Find expressions and sketch the waveforms to scale for the voltage, power, and stored energy, allowing $t$ to range from 0 to $3\pi$ ms. The argument of the sine function is in radians.

6. **Hambley P3.55**

   What value of inductance corresponds to an open circuit, assuming zero initial current? Explain your answer. Repeat for a short circuit.

7. **Hambley P3.74**

   A pair of mutually coupled inductances has $L_1 = 2\,\text{H}$, $L_2 = 1\,\text{H}$, $i_1 = 2\cos(1000t)\text{A}$, $i_2 = 0$, and $v_2 = 2000\sin(1000t)\text{V}$. (The arguments of the sine and cosine functions are in radians.) Find $v_1(t)$ and the magnitude of the mutual inductance.