Discussion 1A

1. **Current, Power, and Energy for a Capacitance (Hambley Example 3.3)**

   Suppose that the voltage waveform shown in Figure 1 is applied to a 10-μF capacitance.

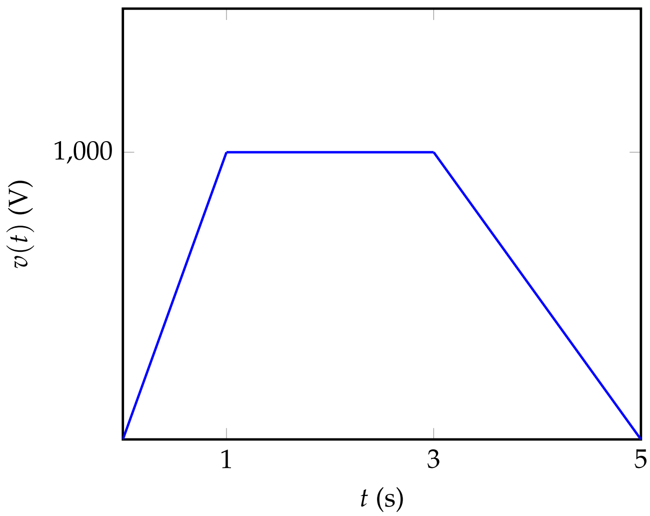

Figure 1: Plot of $v(t)$

Find and plot the current, the power delivered, and the energy stored for time between 0 and 5 s**.**

2. Determining Voltage for a Capacitance Given Current (Hambley Example 3.2)

After t_0 the current in a 0.1 μF capacitor is given by

$$i(t) = 0.5 \sin 10^4 t \tag{1}$$

(The argument of the sin function is in radians.) The initial charge on the capacitor is $q(0) = 0$.

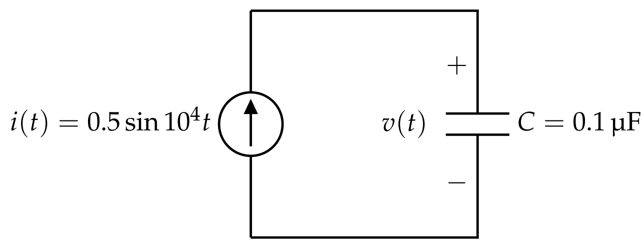

Figure 2: Example Circuit

Plot $i(t)$, $q(t)$, and $v(t)$ to scale versus time.

3. Analyzing an RC Circuit with a Sinusoidal Source (Adapted from Hambley Example 4.4)

Assume you are given the following circuit, where the capacitor is initially charged so that $v_C(t) = 1V$.

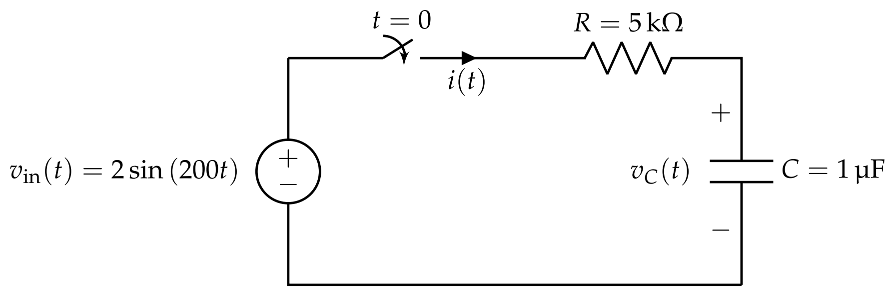

Figure 3

(a) **Set up a differential equation for the voltage $v_C(t)$ across the capacitor in the form:**

$$\frac{\mathrm{d}v(t)}{\mathrm{d}t} + av(t) = b(t) \tag{2}$$

(b) **What is the initial condition of $v(t)$? In other words, what is $v(0)$?**

(c) **Solve for the voltage $v(t)$ through the circuit. Also, identify the transient response (homogeneous solution) and the forced response (particular solution) of $v(t)$.** You may directly use the fact that the solution to a differential equation in the same form as Equation 2 is:

$$v(t) = A\mathrm{e}^{-at} + \mathrm{e}^{-at} \int \mathrm{e}^{at'} b(t')\,\mathrm{d}t' \tag{3}$$

(HINT: The following integral might be useful:

$$\int e^{at} \sin(bt) = \frac{1}{b^2 + a^2} \mathrm{e}^{at} (b \sin(bt) - a \cos(bt)) \tag{4}$$

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(d) **(OPTIONAL) Solve for the current $i(t)$ through the circuit.**