

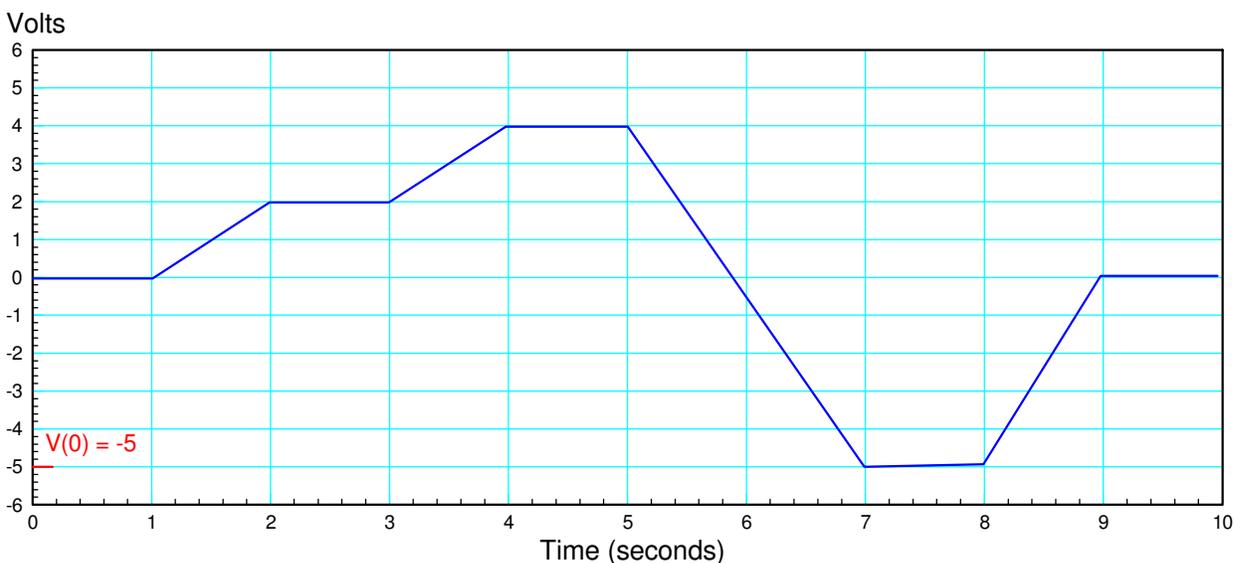
ECE 111 - Make-Up Homework #10

ECE 311 Circuits II - Capacitors & the Heat Equation

1) Assume the current flowing through a one Farad capacitor is shown below. Sketch the voltage. Assume $V(0) = 0$. The voltage is the integral of the current (capacitors are integrators)

$$V = \frac{1}{C} \int I \cdot dt$$

Assume the initial voltage on the capacitor is $-5V$.



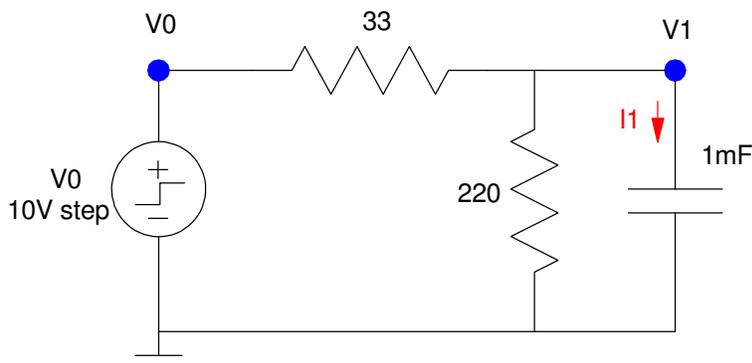
1-Stage RC filter:

2) Write the differential equation that describe this circuit. Note:

$$I_1 = C \frac{dV_1}{dt} = \sum(\text{current to node } V_1)$$

3) Find and plot $V_1(t)$ for two seconds using Matlab.

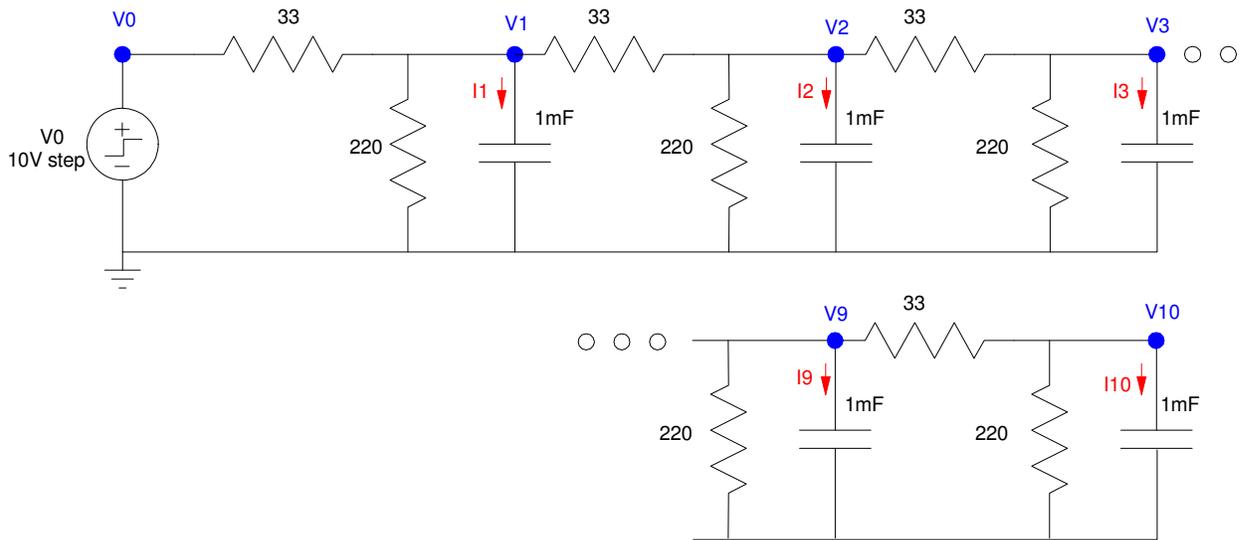
4) Find and plot $V_1(t)$ for two seconds using CircuitLab



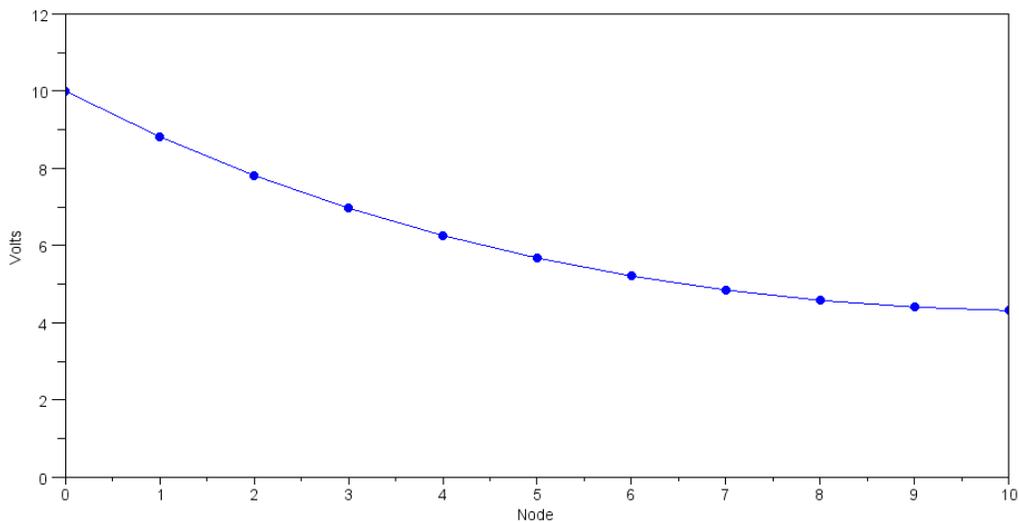
10-Stage RC Filter

5) Write the dynamics for a 10-stage RC filter (repeat for ten stages) as ten coupled differential equations:

$$I_1 = C \frac{dV_1}{dt} = \sum(\text{current to node } V_1)$$



Forced Response for a 10-Node RC Filter (heat.m):



6) Using Matlab, solve these ten differential equations for $0 < t < 5$ s assuming

- The initial voltages are zero, and
- $V_0 = 10V$.

7) Using CircuitLab, find the response of this circuit to a 10V step input. *note: It's OK if you only build this circuit to 3 nodes...*

Natural Response: Eigenvectors and Eigenvalues

8) Assume $V_0 = 0V$. Determine the initial conditions of $V_1..V_{10}$ so that

- The maximum voltage is 10V and
- 5a) The voltages go to zero as slow as possible
- 5b) The voltages go to zero as fast as possible.

Simulate the response for these initial conditions in Matlab.

9) Assume $V_{in} = 0V$. Pick random voltages for $V_1 .. V_{10}$ in the range of (0V, 10V):

$$V = 10 * \text{rand}(10,1)$$

Plot the voltages at $t = 2$. Which eigenvector does it look like?