Discussion 0B

1. KVL/KCL Review

Use Kirchhoff's Laws on the circuit below to find V_x in terms of $V_{\text{in}}, R_1, R_2, R_3$.

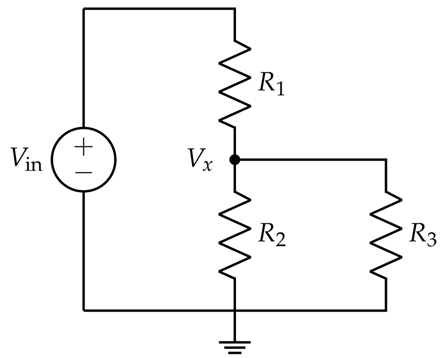


Figure 1: Example Circuit

(a) Recall Node Voltage Analysis (NVA). Determine V_x by labeling the circuit and writing equations to solve a system of equations in node voltages.

(b) In EECS16A, you learned you can simplify analysis by replacing series or parallel resistors with equivalents and memorizing common circuit design blocks. Determine V_x by leveraging resistor equivalence and recognition of a design block.

(c) As a check, as $R_3 \to \infty$, what is V_x for what you found in (a) and (b)? The V_x's of each part should approach the same value. What is the name we used for this type of circuit?

2. Current Sources And Capacitors

(Adapted from EECS16A Fall 20 Disc 9A.)

(HINT: Recall charge has units of Coulombs. (C)*, and capacitance is measured in Farads.* (F)*. Also,* $1\,\text{F} = \frac{1\,\text{C}}{1\,\text{V}}$*. It may also help to note metric prefix examples:* $3\,\mu\text{F} = 3 \times 10^{-6}\text{F}$*.)*

Given the circuit in fig. 2, **find an expression for $v_{\text{out}}(t)$ in terms of I_S, C, V_0, and t**, where V_0 is the initial capacitor voltage at $t = 0$.

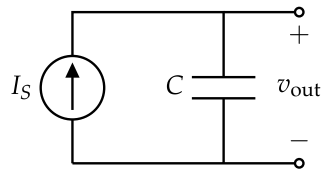


Figure 2: A current source attached to a capacitor.

Then **plot the function $v_{\text{out}}(t)$ over time on the graph below for each set of conditions, detailed below.**

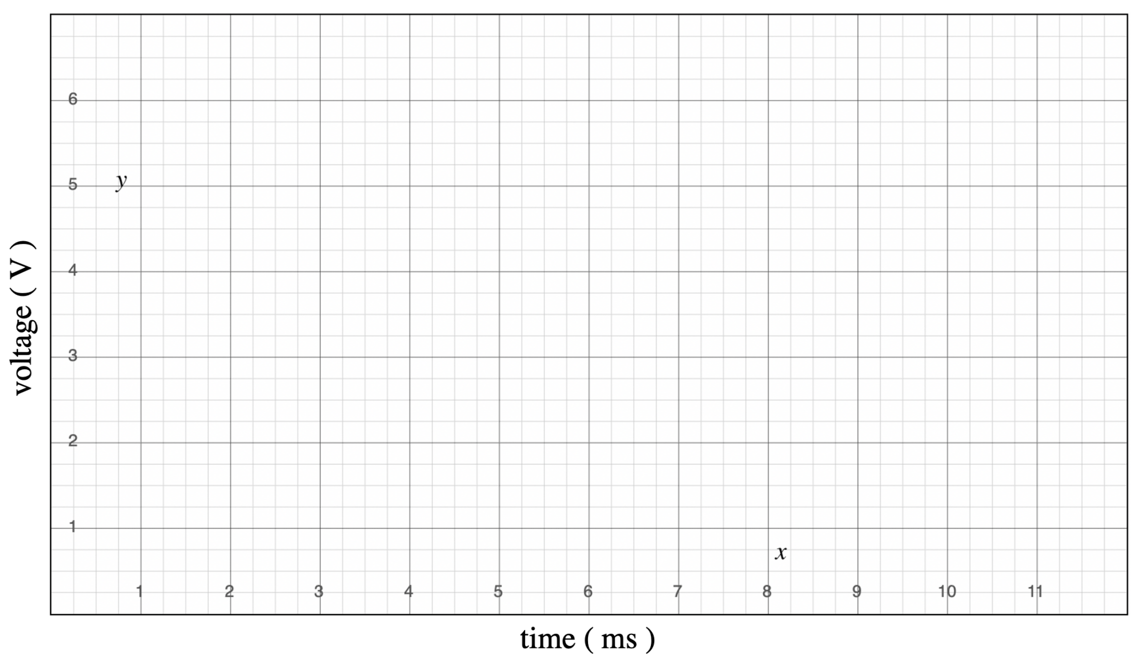
Use the values $I_S = 1\,\text{mA}$ and $C = 2\,\mu\text{F}$.

(1) Capacitor is initially uncharged $V_0 = 0$ at $t = 0$.

(2) Capacitor has been charged with $V_0 = 1.5\,\text{V}$ at $t = 0$.

(3) **(PRACTICE)** Swap this capacitor for one with half the capacitance $C = 1\,\mu\text{F}$, which is initially uncharged $V_0 = 0$ at $t = 0$.

(HINT: Recall the calculus identity $\int_a^b f'(x)\,\mathrm{d}x = f(b) - f(a)$*, where* $f'(x) = \frac{\mathrm{d}f}{\mathrm{d}t}$*.)*



3. Op-Amp Summer

Consider the following circuit (assume the op-amp is ideal):

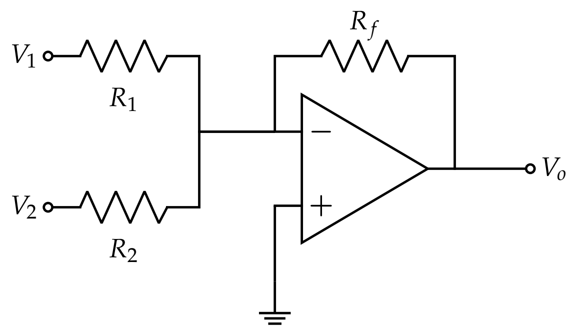


Figure 3: Op-amp Summer

What is the output V_o in terms of V_1 and V_2? You may assume that R_1, R_2, and R_f are known.

