1. Voltages Across Capacitors

For the circuits given below, calculate the voltage across the capacitors. For parts (a) and (b) only, also calculate the charge and energy stored in each capacitor. Let \( C_1 = 1 \mu F \), \( C_2 = 3 \mu F \), \( V_s = 1 \) V, and \( I_s = 2 \) mA.

(a)

\[ \text{\begin{circuitikz}
    
    
    
    \end{circuitikz}} \]

(b)

\[ \text{\begin{circuitikz}
    
    
    \end{circuitikz}} \]

(c)

\[ \text{\begin{circuitikz}
    
    \end{circuitikz}} \]

2. Capacitors and Charge Conservation (with Energy!)

(a) Consider the circuit below with \( C_1 = C_2 = 1 \mu F \) and an open switch. Suppose that \( C_1 \) is initially charged to +1 V and that \( C_2 \) is charged to +2 V. How much charge is on \( C_1 \) and \( C_2 \)? How much energy is stored in each of the capacitors? What is the total stored energy?

\[ \text{\begin{circuitikz}
    
    \end{circuitikz}} \]
(b) Now the switch is closed (i.e. the capacitors are connected together.) Is charge conserved? What are the voltages across and the charges on \(C_1\) and \(C_2\)? What is the total stored energy?

(c) Is there more or less energy than before the switch was closed? Why?

(d) Answer the above three questions but now with \(C_1 = 2\mu\text{F}\) and \(C_2 = 1\mu\text{F}\). Suppose that they are initially charged in the same way: \(C_1\) is charged to +1 V, and \(C_2\) is charged to +2 V.

3. Comparators

For each of the circuits shown below, plot \(V_{\text{out}}\) for \(V_{\text{in}}\) ranging from \(-10\) V to 10 V for part (a) and from 0 V to 10 V for part (b).

(a)

(b)