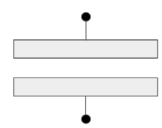
EECS 16A Designing Information Devices and Systems I
Spring 2022 Discussion 8B

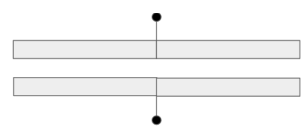
1. Capacitance Equivalence

For the structures shown below, assume that the plates have a depth L into the page and a width W and are always a distance d apart. The dielectric between the plates has absolute permitivity ε. For the following calculations, assume the capacitance is purely parallel plate, i.e. ignore fringing field effects.

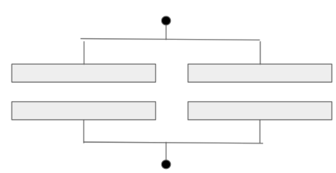
(a) What is the capacitance of the structure shown below?



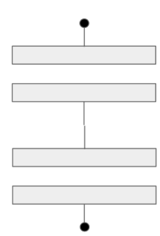
(b) Suppose that we take two such structures and put them next to each other as shown below. What is the capacitance of this new structure?



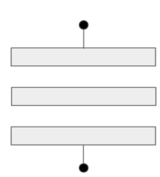
(c) Now suppose that rather than connecting them together as shown above, we connect them with an ideal wire as shown below. What is the capacitance of this structure?



(d) Suppose that we now take two capacitors and connect them as shown below. What is the capacitance of the structure?

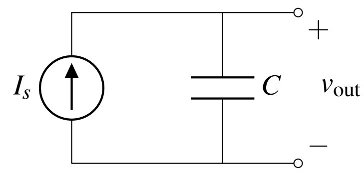


(e) What is the capacitance of the structure shown below?



2. Current Sources And Capacitors

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



Then plot the function $v_{\text{out}}(t)$ over time on the graph below for the following conditions detailed below. Use the values $I_s = 1\text{mA}$ and $C = 2\,\mu\text{F}$.

(a) Capacitor is initially uncharged, with $V_0 = 0$ at $t = 0$.

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

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

HINT: Recall the calculus identity $\int_a^b f'(x)dx = f(b) - f(a)$, where $f'(x) = \frac{df}{dx}$.