
EECS 16A Designing Information Devices and Systems I

Fall 2022 Discussion 9A

Mid Semester Survey

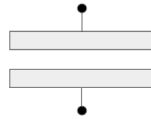
Please fill out the mid semester survey: <https://tinyurl.com/midsemester16a>

We highly appreciate your feedback!

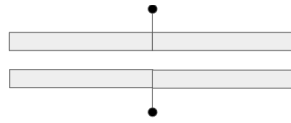
1. Capacitance Equivalence

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 permittivity ϵ . For the following calculations, assume the capacitance is purely parallel plate, i.e. ignore fringing field effects.

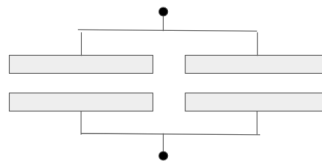
- (a) What is the capacitance of the structure shown below?



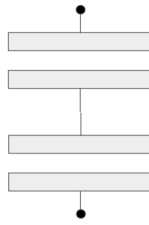
- (b) Suppose that we take two such structures and put them next to each other as shown below. What is the capacitance of this new structure?



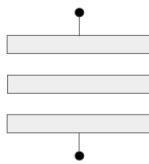
- (c) Now suppose that rather than connecting them together as shown above, we connect them with an ideal wire as shown below. What is the capacitance of this structure?



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



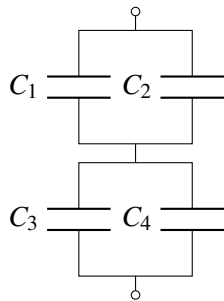
- (e) What is the capacitance of the structure shown below?



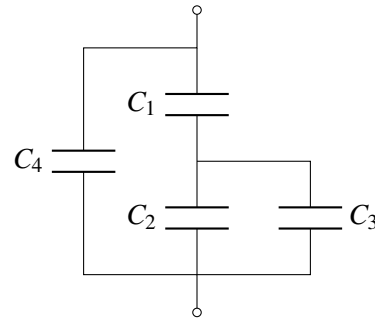
2. Series And Parallel Capacitors

Derive C_{eq} for the following circuits.

(a)

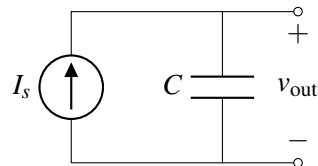


(b)



3. Current Sources And Capacitors

Given the circuit below, find an expression for $v_{out}(t)$ 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 $v_{out}(t)$ 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 $f'(x) = \frac{df}{dx}$.

