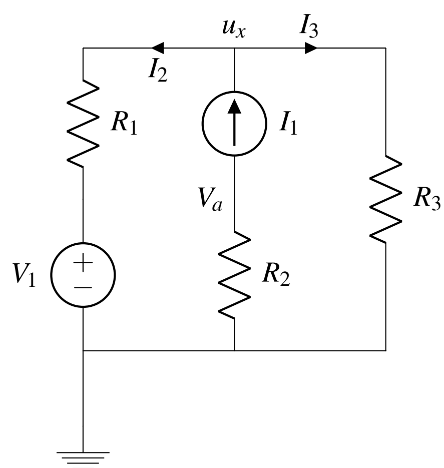
CSM 16A Designing Information Devices and Systems I
Spring 2021 Week 7

1. Superposition

Learning Goal: This problem aims to make students familiar with the technique of superposition. It will also show how to nullify different types of sources in the process.

Relevant Notes: **Note 15: Section 15.3** goes over the principle of superposition. Some intuition behind why superposition works is that we can calculate the result from each source independently and add the results up (Note 15). Think of the multiple sources (ex. voltage source, current source, etc.) like basis vectors that are orthogonal to each other or equations that are linearly independent - in other words they have no relation to each other. So we can add them up to get our final result!

Solve the following circuit for u_x using superposition. Let $R_1 = 10\Omega$, $R_2 = 5\Omega$, $R_3 = 2\Omega$, $V_1 = 12V$, and $I_1 = 3A$.



(a) Find u_x when only V_1 is active.

(b) Find u_x when only I_1 is active.

(c) Use your results from the last two parts to find u_x when all the sources are active.

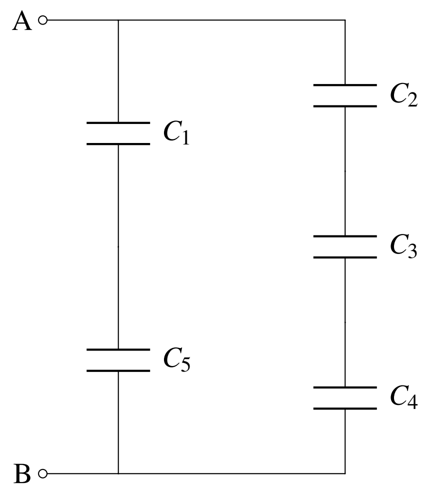
2. Equivalence in Capacitive Networks

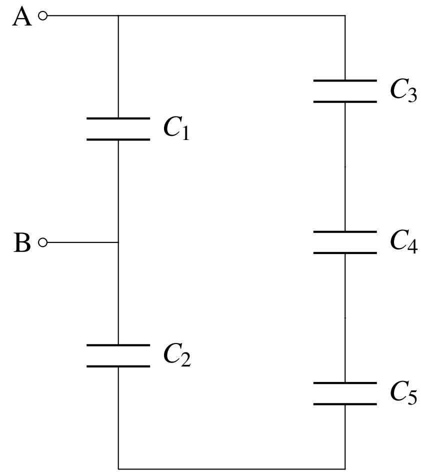
Learning Goal: This objective of this problem is to practice finding equivalent capacitance for series/parallel network of capacitors.

Relevant Notes: **Note 16** derives the equivalent capacitance formula for series/ parallel capacitors.

For all of the following networks find an expression or a numerical value for the equivalent capacitance between terminals A and B.

(a)



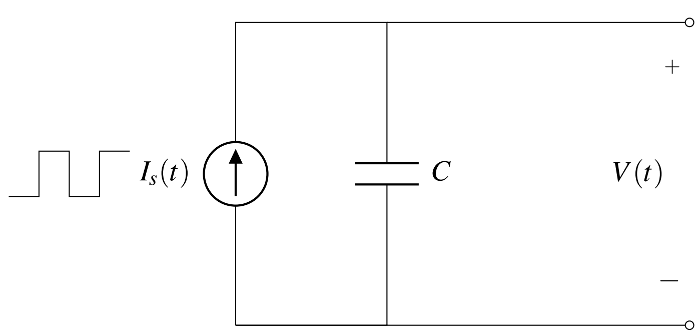
(b) 

3. **Capacitor with a Periodic Current Source**

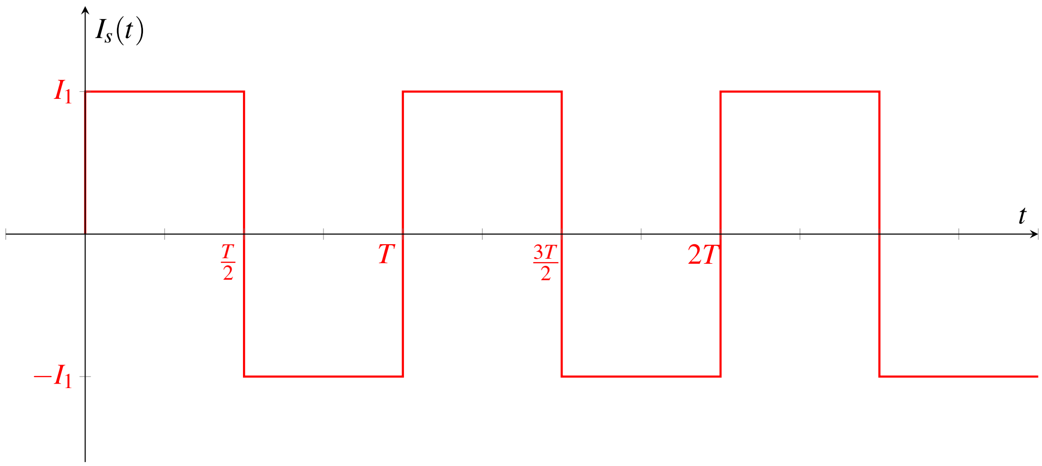
   Learning Goal: This problem aims to make students familiar with the charging/ discharging response of a capacitor.

   Relevant Notes: **Note 17** covers capacitive behavior in the presence of difference types of current sources.

   Capacitive touchscreen requires detection of capacitance change due to touch. If we connect a known current source I_s to the capacitor and measure the voltage across the capacitor V, we will be able to solve for the capacitance C. So we build the following circuit to measure with a periodic current source:

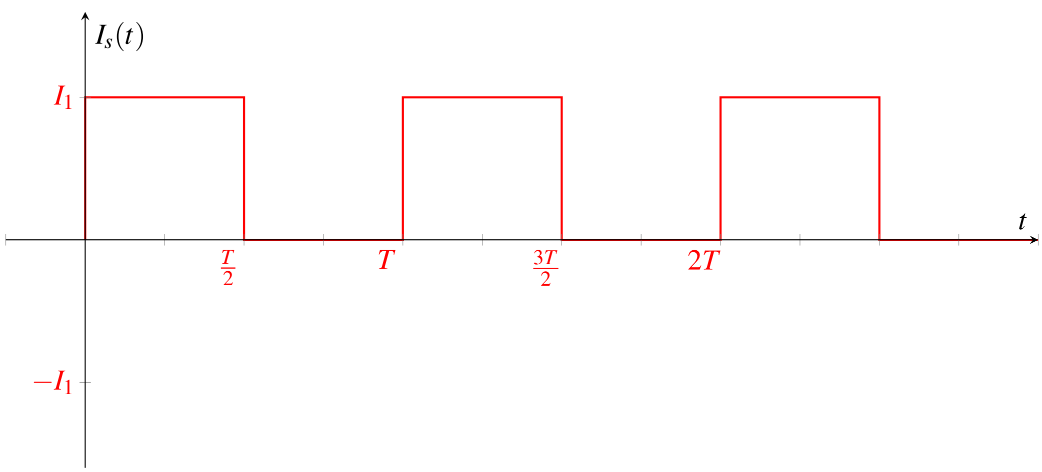


   (a) Let us assume the current I_s is a function of time as follows:



What does the voltage V look like with this current source? Let's assume that the capacitor is initially uncharged (i.e. $Q = 0$). Since $Q = CV$, this means that at time $t = 0$ the voltage $V = 0$.

(b) Now let us assume the current I_s is a function of time as follows:



What does the voltage V qualitatively look like with this current source? Draw out on the above graph how the voltage changes over time, starting at time $t = 0$. Let's assume that the capacitor is initially uncharged (i.e. $Q = 0$). Since $Q = CV$, this means that at time $t = 0$ the voltage $V = 0$.

