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.

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

(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.

![Diagram of capacitive network](image)
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 different 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 $V = 0$. 