1. Voltage Divider

For the circuit below, your goal will be to find the voltage \( V_{out} \) in terms of the resistances \( R_1, R_2, \) and \( V_s, \) using NVA (Node Voltage Analysis) and Gaussian elimination. The labeling steps (steps 1-4) have already been done for you.

Here is a reminder of the labeling steps followed to get the circuit diagram above:

- **Step 1:** Select a reference (ground) node. Any node can be chosen for this purpose. We will measure all of the voltages in the rest of the circuit relative to this point.
- **Step 2:** Label all nodes with voltage set by voltage sources.
- **Step 3:** Label remaining nodes.
- **Step 4:** Label element voltages and currents, following **Passive Sign Convention**.

Our goal is to **find** \( V_{out} \). In order to do this, we can use NVA to find equations describing our circuit, write our equations in the form \( A\bar{x} = \bar{b} \), and use Gaussian elimination to solve for \( \bar{x} \). The following steps will walk you through this process:

**Step 5:** Write out \( A\bar{x} = \bar{b} \), leaving the entries for \( A \) and \( \bar{b} \) blank. Next, fill in the entries for \( \bar{x} \). Recall that \( \bar{x} \) is a vector of your unknown currents and voltages.

**Step 6:** Write KCL equations for all nodes with unknown voltages. Using these equations, fill in as many linearly independent rows in \( A \) and \( \bar{b} \) as possible.

**Step 7:** Write down the IV relationships (Ohm’s Law) of each of the non-wire elements. Use these equations to fill in the remaining rows in \( A \) and \( \bar{b} \). (Hint: how many equations do you need to write?)

**Step 8:** Use Gaussian elimination or substitution to solve for \( u_2 = V_{out} \).
2. KVL and KCL

For the circuit shown below, $V_s = 5 \text{ V}$, $R_1 = R_2 = 4 \text{k}\Omega$, and $R_3 = R_4 = 2 \text{k}\Omega$.

(a) For the circuit above, write KVL equations for each loop and KCL equations for each node.

(b) Solve for the voltage between $A$ and $B$ using the equations from part (a).