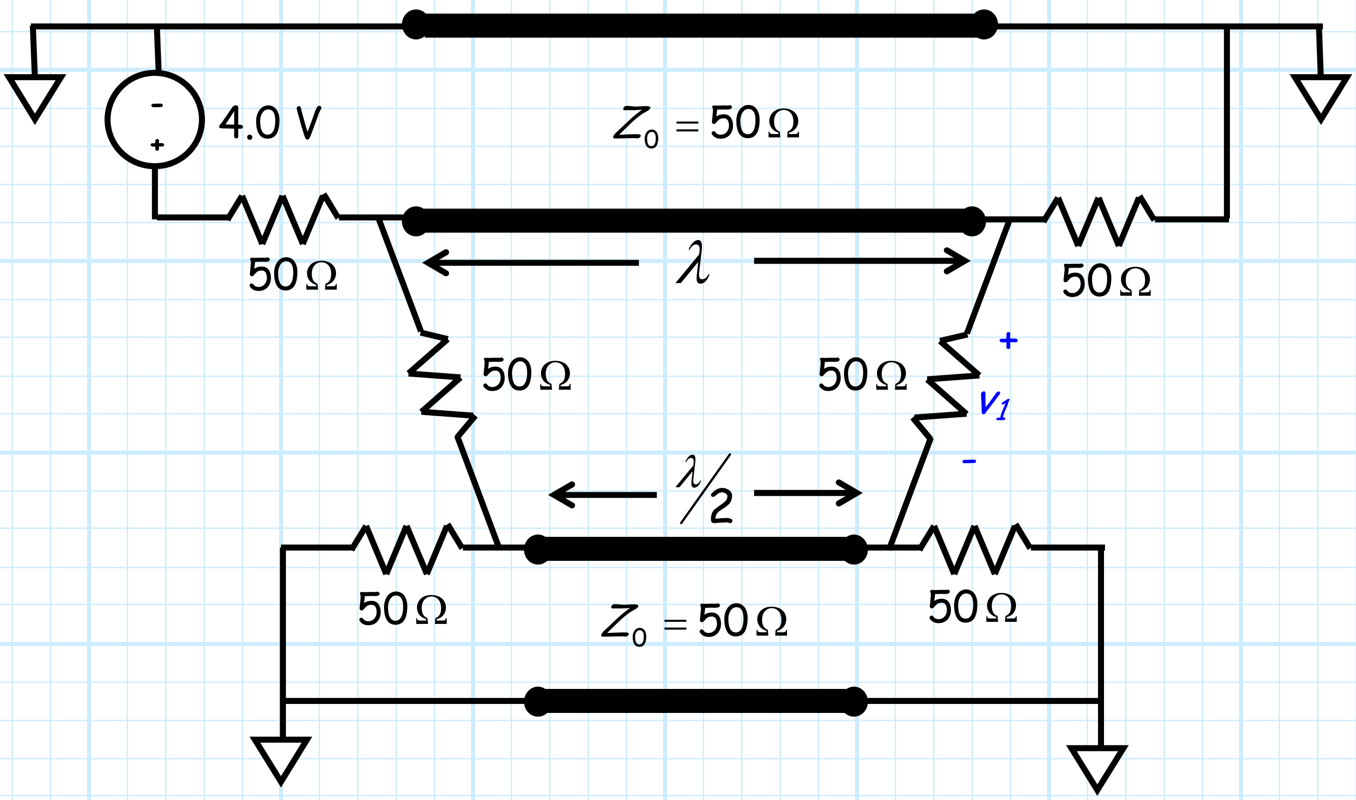
Example: Odd-Even Mode Circuit Analysis

Carefully (**very** carefully) consider the **symmetric** circuit below.

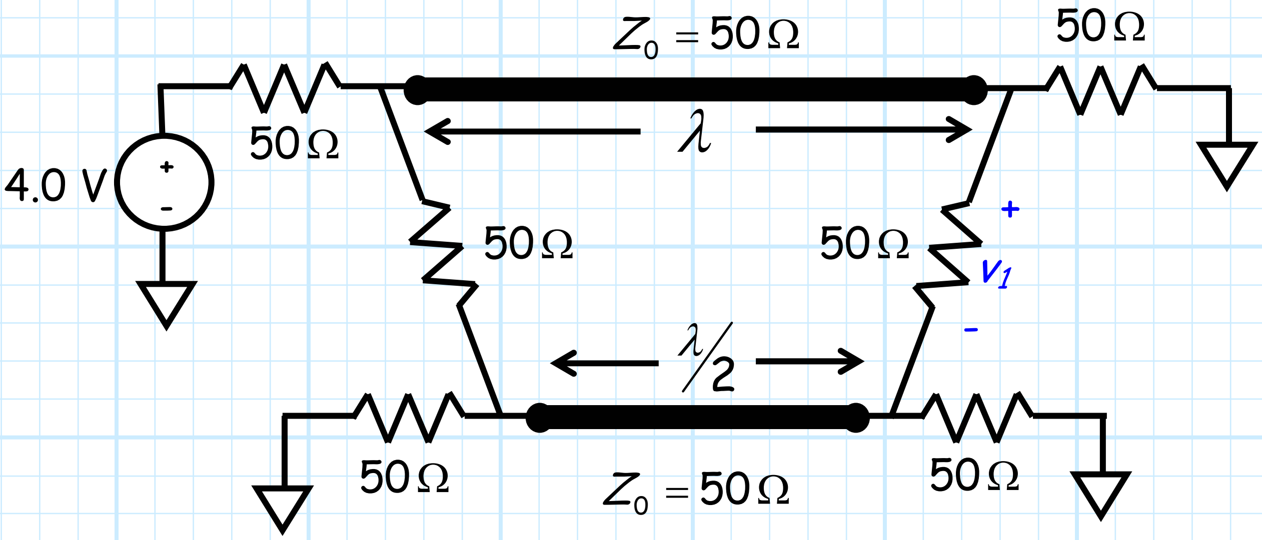


The two transmission lines each have a characteristic impedance of .

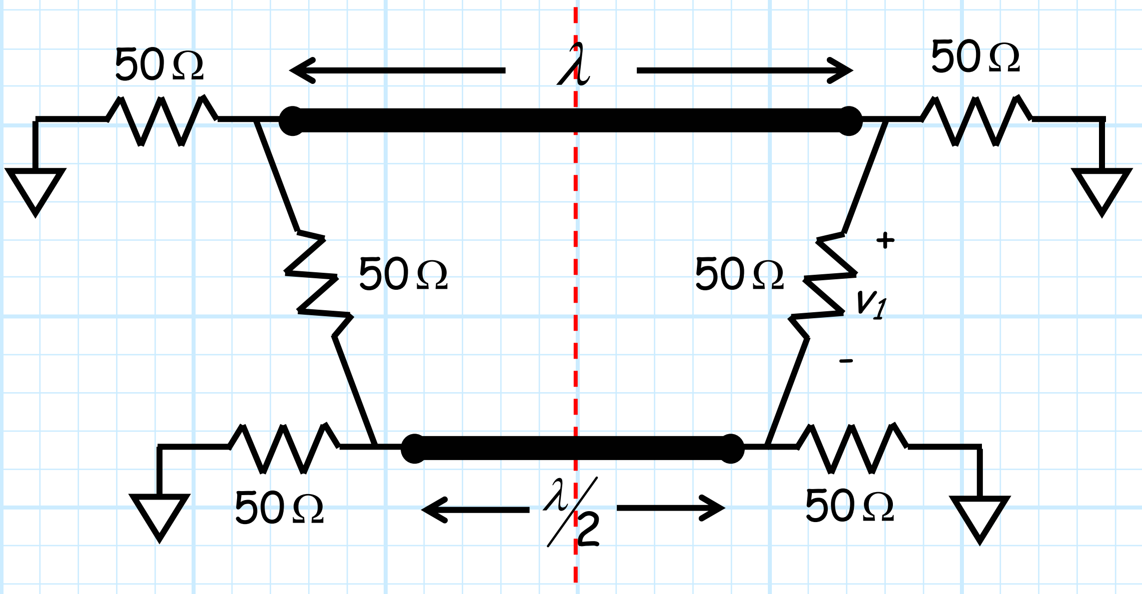
> Use **odd-even mode analysis** to determine the value of voltage v_1.

Solution

To simplify the circuit schematic, we first remove the bottom (i.e., ground) conductor of each transmission line:

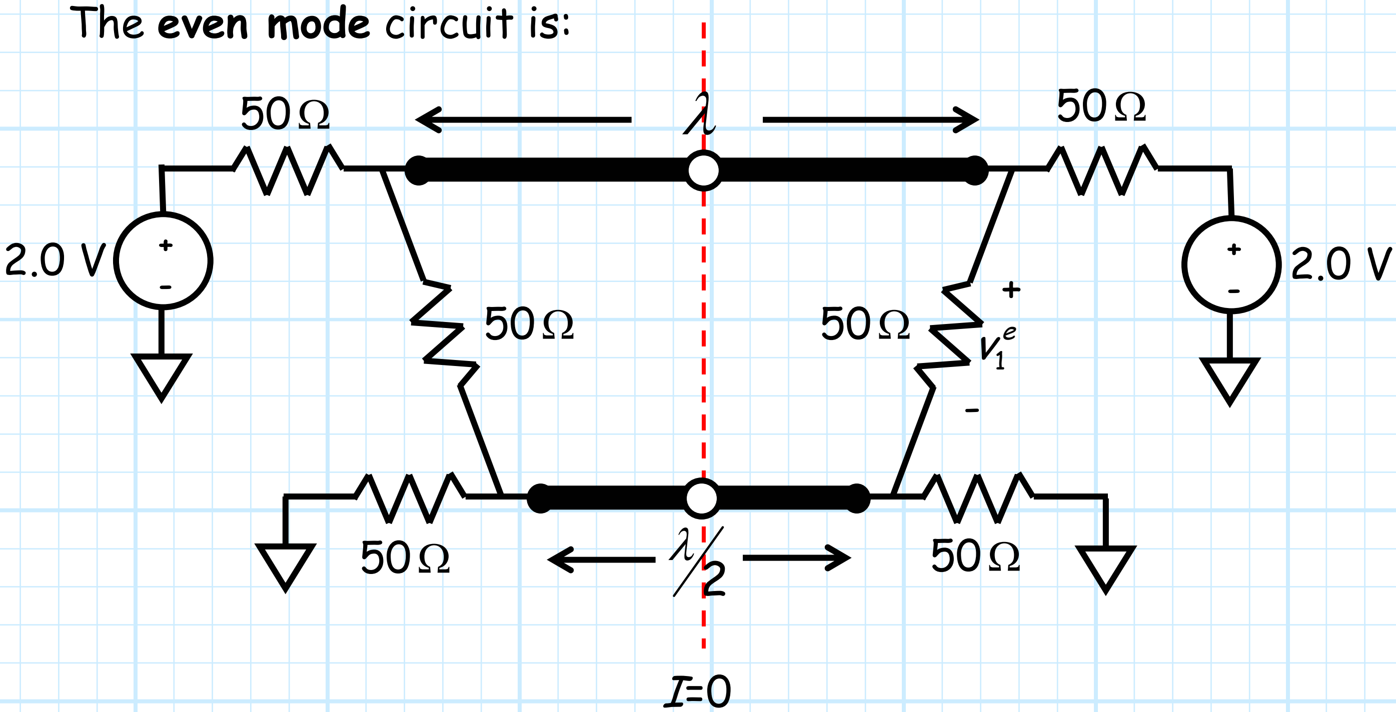


Note that the circuit has one plane of **bilateral symmetry**:

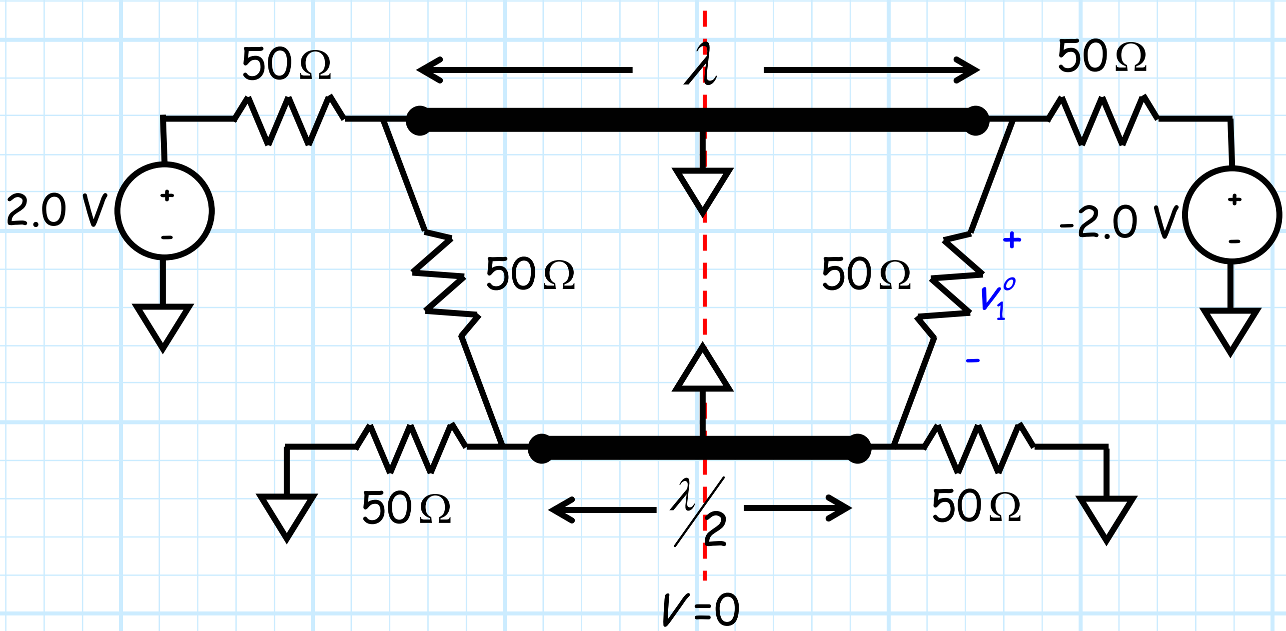


Thus, we can analyze the circuit using **even/odd mode analysis** (Yeah!).

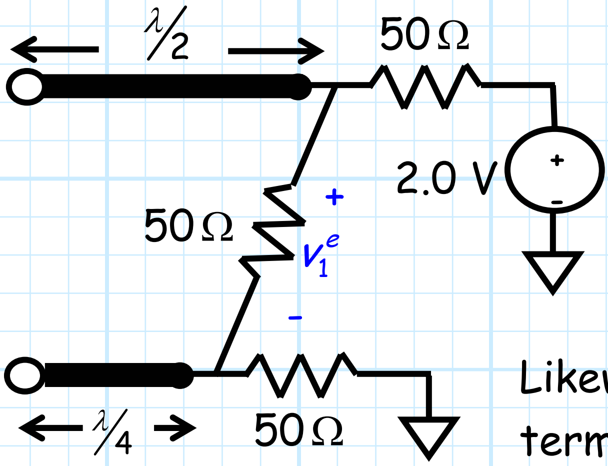
The **even mode** circuit is:



Whereas the **odd mode** circuit is:



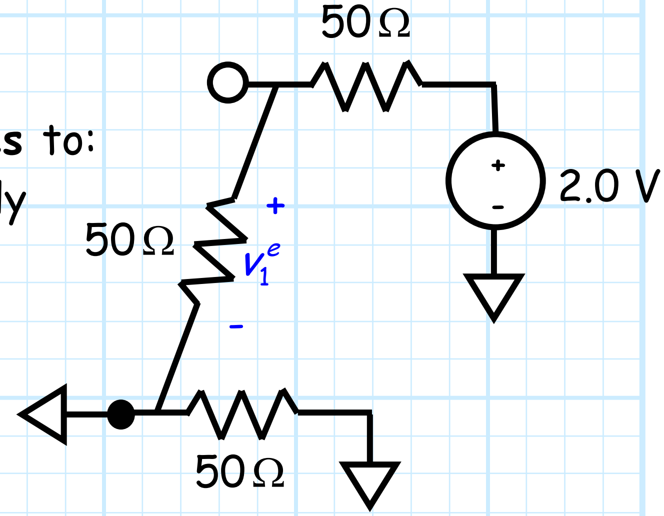
We split the modes into half-circuits from which we can determine voltages v_1^e and v_1^o:



Recall that a $\ell = \lambda/2$ transmission line terminated in an open circuit has an input impedance of $Z_{in} = \infty$—an **open** circuit!

Likewise, a transmission line $\ell = \lambda/4$ terminated in an open circuit has an input impedance of $Z_{in} = 0$—a **short** circuit!

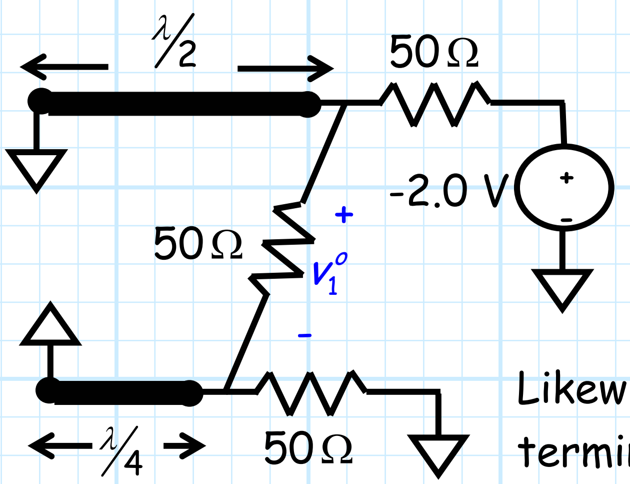
Therefore, this half-circuit **simplifies** to:



And therefore the voltage v_1^e is easily determined via voltage division:

$$v_1^e = 2\left(\frac{50}{50+50}\right) = 1.0\ V$$

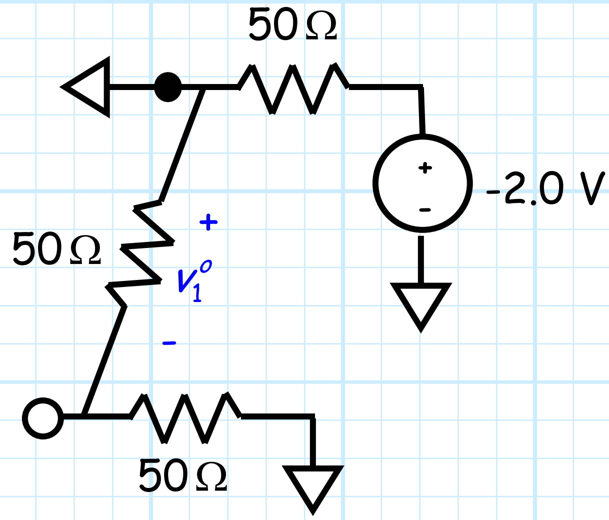
Now, examine the right half-circuit of the **odd mode**:



Recall that a $\ell = \lambda/2$ transmission line terminated in a short circuit has an input impedance of $Z_{in} = 0$— a **short** circuit!

Likewise, a transmission line $\ell = \lambda/4$ terminated in an short circuit has an input impedance of $Z_{in} = \infty$— an **open** circuit!

This half-circuit simplifies to →



It is apparent from the circuit that the voltage $V_1^o = 0$!

Thus, the superposition of the odd and even modes leads to the result:

$$\underline{\underline{V_1}} = V_1^e + V_1^o = 1.0 + 0 = \underline{\underline{1.0\ V}}$$