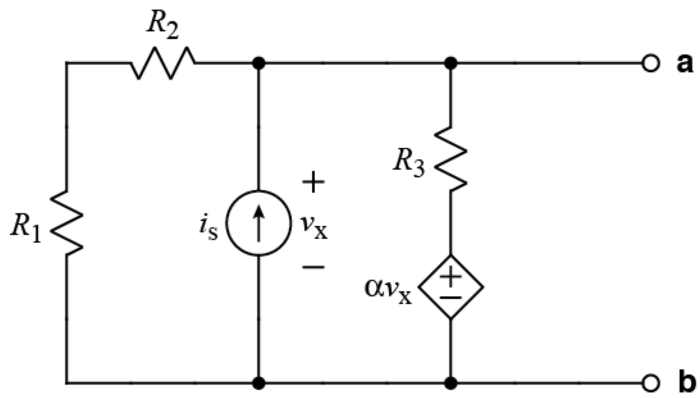
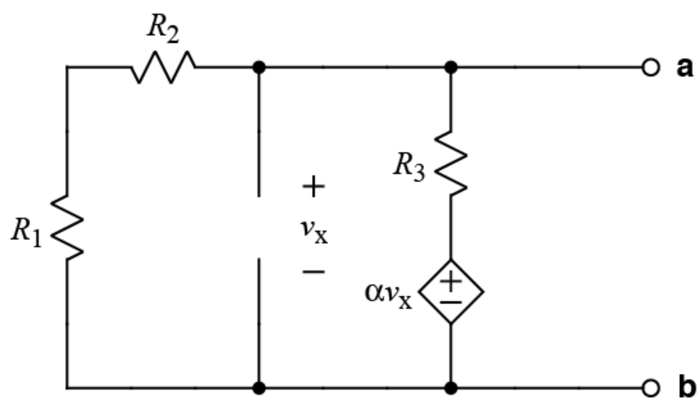
EX: Find the equivalent resistance of the dependent source in the circuit shown below.

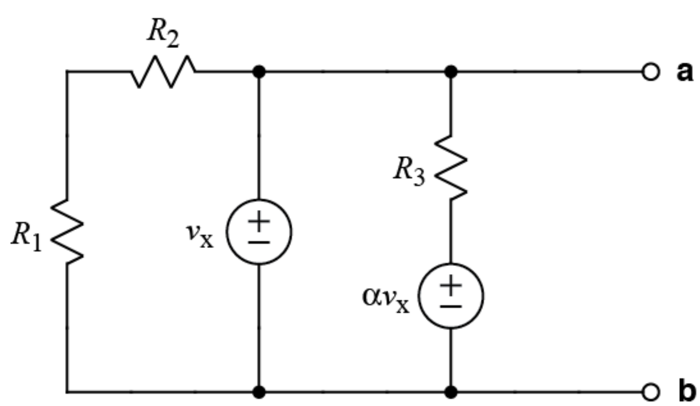


SOL'N: i) Turn off the independent source.

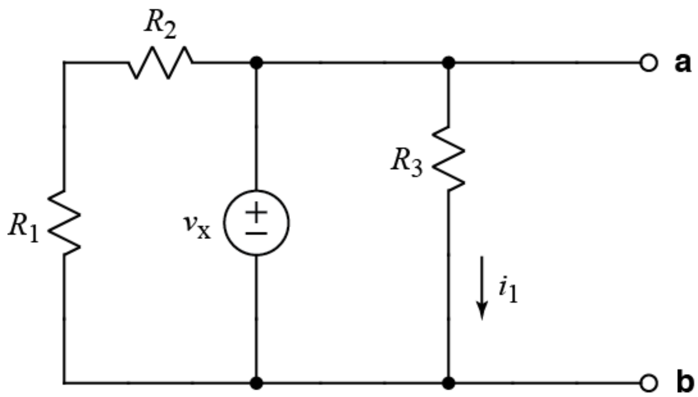


ii) Replace the part of the circuit where dependent variable v_x is measured with an independent voltage source (since the variable being measured is v_x). Note that the original current source has become a voltage source.

iii) Treat the dependent source as an independent voltage source of value αv_x.



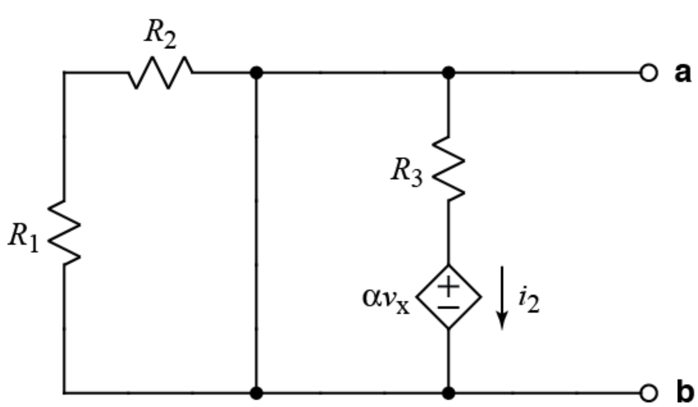
iv) Use superposition to calculate the current in the dependent source in terms of v_x. First, turn on the v_x source and turn off the αv_x source. Find the current through the dependent source (which is now a wire) in terms of v_x. We refer to this current as i_1:



The current is found by applying Ohm's law.

$$i_1 = \frac{v_x}{R_3}$$

v) Second, turn on the αi_x voltage source and turn off the i_x source. (Since the i_x source is a current source, it becomes an open circuit when turned off.) Find the current in the dependent source in terms of i_x. We refer to this current as i_2:

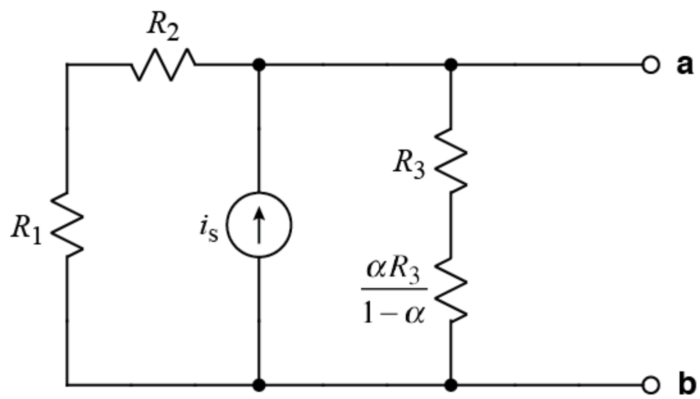


$$i_2 = -\frac{\alpha v_x}{R_3}$$

vi) Third, sum the two currents above and use Ohm's law to calculate the equivalent resistance of the dependent source as the voltage of the dependent source divided by the current of the dependent source:

$$R_{Eq} = \frac{\alpha v_x}{i_1 + i_2} = \frac{\alpha v_x}{\frac{v_x}{R_3} - \frac{\alpha v_x}{R_3}} = \frac{\alpha R_3}{1-\alpha}$$

The equivalent resistance now replaces the dependent source:



Summing the two resistors on the right side yields an even simpler circuit:

$$\frac{\alpha R_3}{1-\alpha} + R_3 = \frac{\alpha R_3}{1-\alpha} + \frac{R_3(1-\alpha)}{1-\alpha} = \frac{R_3}{1-\alpha}$$