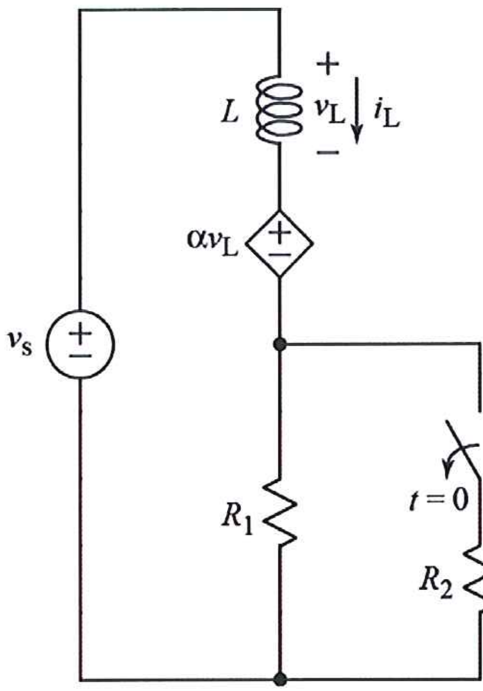
Ex:



After being closed for a long time, the switch opens at $t = 0$.

For the above circuit, determine whether the dependent source acts like an R, an L, or both. Explain your answer by finding the equivalent value of the R, L, or both that give(s) the same solution as the original problem.

sol'n: The sol'n for $i_L(t>0)$ in the above problem is as follows (see related problem for derivation):

$$i_L(t>0) = i_L(t\to\infty) + [i_L(0^+) - i_L(t\to\infty)]e^{-t/\tau}$$

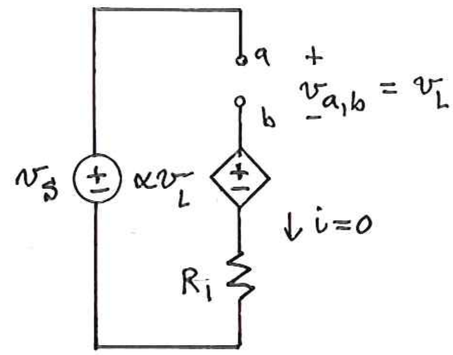
or

$$i_L(t>0) = \frac{v_S}{R_1} + \frac{v_S}{R_2} e^{-t/(1+\alpha)L/R_1}$$

This solution is for L connected to the circuit that includes the dependent source.

We may think of the circuit without L as a Thevenin equivalent. From our sol'n above, we have $R_{Th} = R_1/(1+\alpha)$.

To find v_{Th}, we find the $v_{a,b}$ for the following circuit:



Because we have an open circuit $i=0$, and R has no v-drop. For a v-loop, we get

$$v_s - v_{ab} - \alpha v_{ab} - 0V = 0V$$

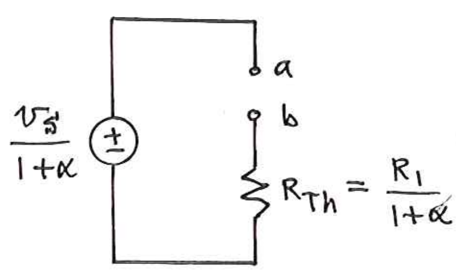
or

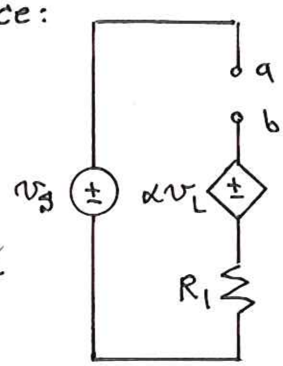
$$v_{ab}(1+\alpha) = v_s$$

or

$$v_{ab} = \frac{v_s}{1+\alpha}$$

If we use a Thevenin equivalent, we have the following equivalence:





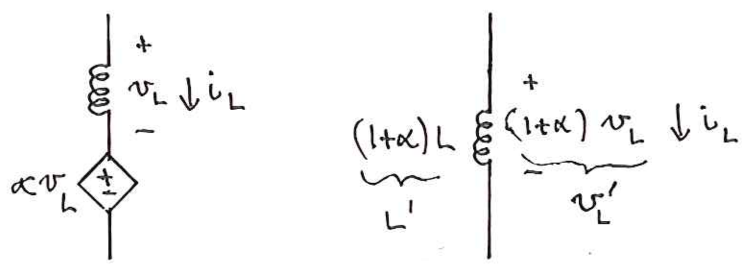
We could remove the αv_L source and consider it to be part of the R_{Th}, if we also adjust the independent source. If we accept this change in v_S, then our αv_L source becomes an R_{eq}:

$$R_1 + R_{eq} = \frac{R_1}{1+\alpha}$$

or

$$R_{eq} = \frac{R_1}{1+\alpha} - R_1 = \frac{R_1}{1+\alpha} - \frac{R_1(1+\alpha)}{1+\alpha} = \frac{-\alpha R_1}{1+\alpha}$$

On the other hand, we may argue that the L and αv_L source act exactly like $(1+\alpha)L$:



$v_L = L\dfrac{di_L}{dt}$	$v_L' = L'\dfrac{di_L}{dt}$
	$v_L' = (1+\alpha)L\dfrac{di_L}{dt}$
$v_L + \alpha v_L = L\dfrac{di_L}{dt} + \alpha L\dfrac{di_L}{dt}$	$v_L' = (1+\alpha)v_L$
$v_L + \alpha v_L = (1+\alpha)L\dfrac{di_L}{dt}$	$(1+\alpha)v_L = (1+\alpha)L\dfrac{di_L}{dt}$
$(1+\alpha)v_L = (1+\alpha)L\dfrac{di_L}{dt}$	

We can stay that the dependent source looks like an L_{eq} of value αL.