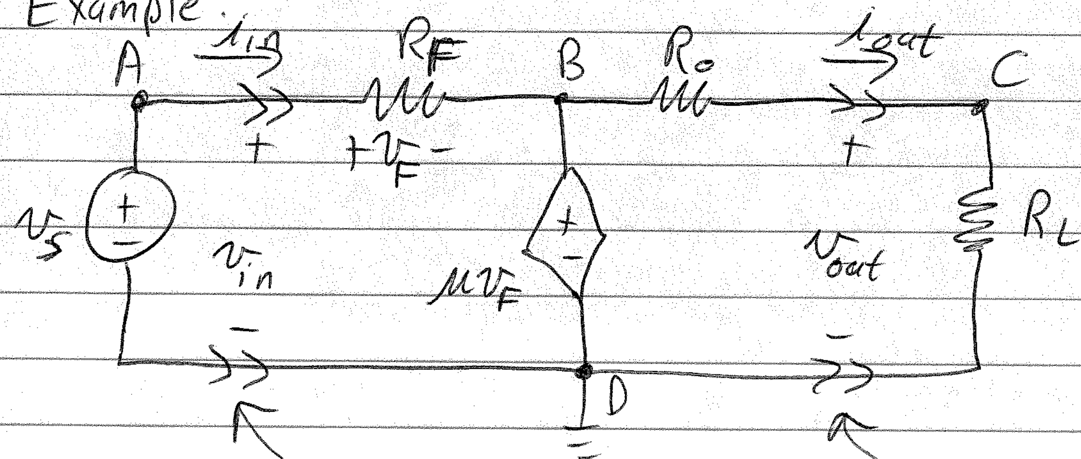
Thevenin + Norton Equiv. Ckts w/ Dependent Sources

We have to make sure the dependent sources are active, so ~~the best way is to~~ we must either find V_{oc} + I_{sc}, or analyze the complete ckt to find v_{in} + i_{in}, then take

$$R_s = \frac{V_{oc}}{I_{sc}} \quad \text{or} \quad R_s = \frac{v_{in}}{i_{in}}$$

Example:



Find the input resistance and the Thevenin Equivalent Output Ckt for this ckt.

Nodal Analysis

~~Input~~ $v_A = v_S$, $v_B = \mu v_F = \mu(v_A - v_B)$

$$v_F = (v_A - v_B)$$

$$(\mu+1) v_B = \mu v_A = \mu v_S$$

$$v_B = \frac{\mu}{\mu+1} v_S$$

(C) $$\frac{v_c - v_B}{R_o} + \frac{v_c}{R_L} = 0$$

$$-\frac{1}{R_o} v_B + \left(\frac{1}{R_o} + \frac{1}{R_L}\right) v_c = 0$$

$$-\frac{1}{R_o} v_B + \left(\frac{R_o + R_L}{R_o R_L}\right) v_c = 0$$

$$v_c = \left(\frac{R_o R_L}{R_o + R_L}\right)\left(\frac{1}{R_o}\right)\left(\frac{\mu}{\mu+1}\right) v_S = v_{out}$$

Input Resistance

$$R_{in} = \frac{v_{in}}{i_{in}} = \frac{v_S}{\frac{v_A - v_B}{R_F}} = \frac{R_F v_S}{(v_A - v_B)}$$

$$R_{in} = \frac{R_F v_S}{v_S - \frac{\mu}{\mu+1} v_S} = \frac{R_F}{\left(\frac{\mu+1-\mu}{\mu+1}\right)} = \boxed{(\mu+1) R_F = R_{in}}$$

Output Thev. Equiv.

$$v_{oc} = \lim_{R_L \to \infty} v_{out}$$

$$= \lim_{R_L \to \infty} \frac{\cancel{R_L} \; R_O \, \mu}{\cancel{R_L}\left(1 + \underbrace{\frac{R_O}{R_L}}_{\to 0}\right) R_O(\mu+1)} v_S$$

$$\boxed{v_{oc} = \frac{\mu}{\mu+1} v_S}$$

$$R_S = \cancel{\frac{v_{out}}{i_{out}}} \frac{v_{oc}}{i_{sc}} \qquad i_{out} = \frac{v_B - v_C}{R_O}$$

$$v_{out} = \left(\frac{R_L}{R_O+R_L}\right)\frac{\mu}{(\mu+1)} v_S \qquad = \frac{\frac{\mu}{\mu+1} v_S - \frac{R_L}{R_O+R_L}\frac{\mu}{\mu+1} v_S}{R_O}$$

$$i_{out} = \frac{\frac{\mu}{\mu+1}\left[1 - \frac{R_L}{R_O+R_L}\right] v_S}{R_O}$$

$$= \frac{\frac{\mu}{\mu+1}\left[\cancel{\frac{R_O}{R_O+R_L}}\right] v_S}{R_O}$$

$$= \left(\frac{\mu}{\mu+1}\right)\left(\frac{1}{R_O+R_L}\right) v_S$$

$$\cancel{R_S = \frac{\left(\frac{R_L}{R_O+R_L}\right)\left(\frac{\mu}{\mu+1}\right) v_S}{\left(\frac{1}{R_O+R_L}\right)\left(\frac{\mu}{\mu+1}\right) v_S}}$$

$$\cancel{R_S = R_L}$$

$$i_{sc} = \lim_{R_L \to 0} i_{out} = \frac{\mu}{(\mu+1)} \frac{1}{R_O} v_S$$

$$R_S = \frac{v_{oc}}{i_{sc}} = \frac{\frac{\mu}{\mu+1} v_S}{\left(\frac{\mu}{\mu+1}\right)\left(\frac{1}{R_O}\right) v_S} = R_O$$

So the Thev. Equiv is