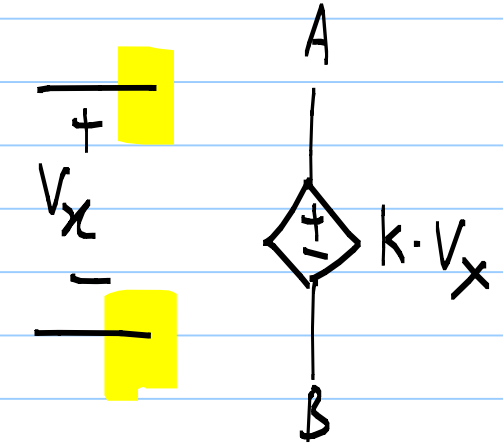
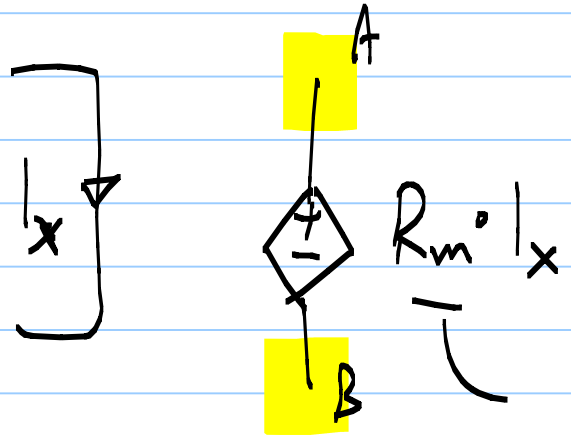
EE 2015

Dependent sources
Controlled sources

8/8/2017

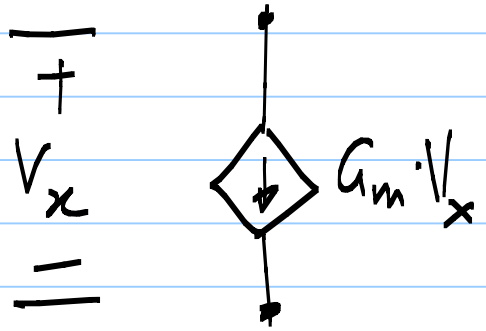


Voltage controlled voltage source
(VCVS)

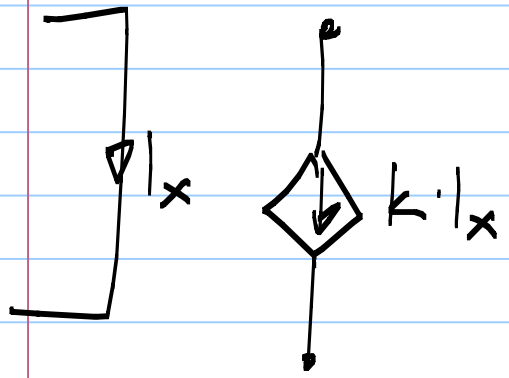


Current controlled voltage source
(CCVS)

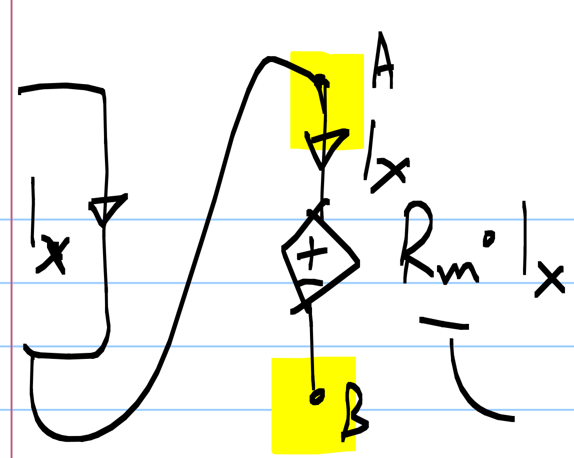
R_m — Trans resistance

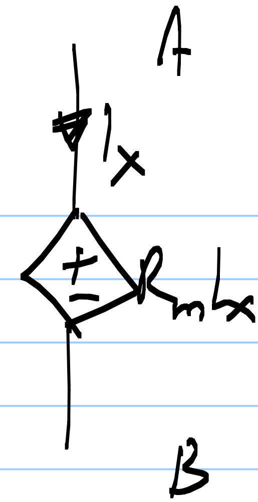


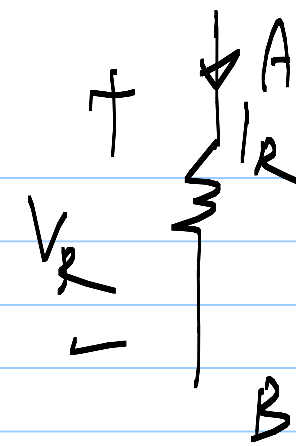
Voltage controlled current source (VCCS)



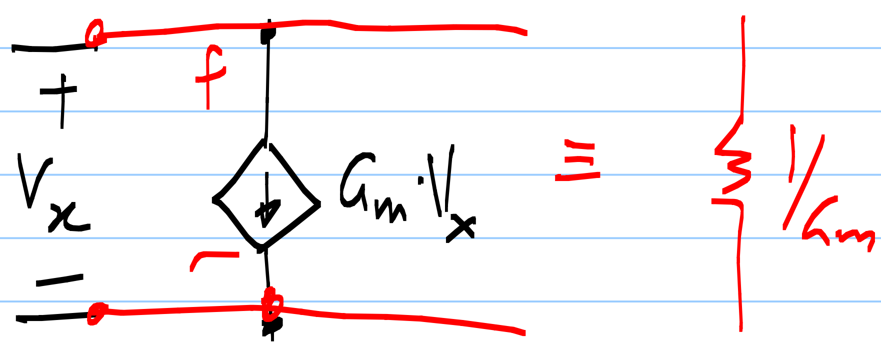
Current controlled current source (CCCS)



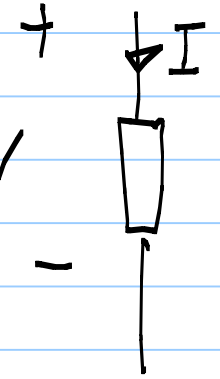




$V_R = R \cdot I_R$



Power and energy:



$p = V \cdot I$: Power absorbed in the element

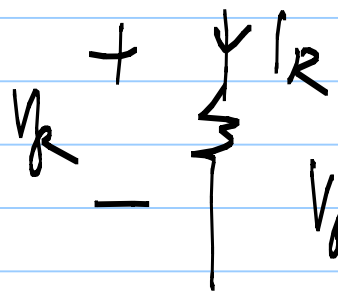
Passive element $\Rightarrow V \cdot I \geq 0$

$P_R \geq 0$

$E_R \geq 0$

Dissipates power

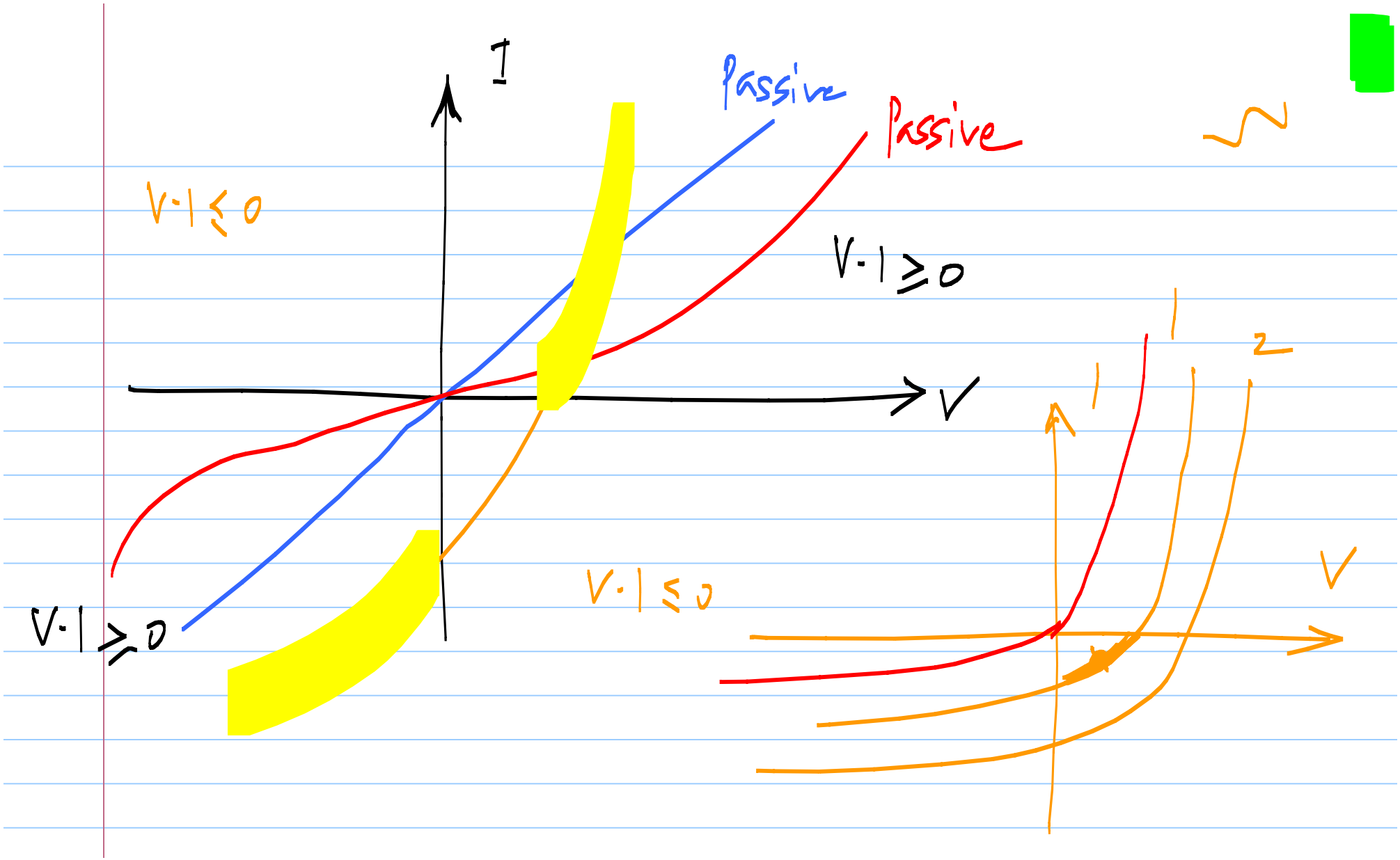
Resistor:



$V_R = R \cdot I_R$

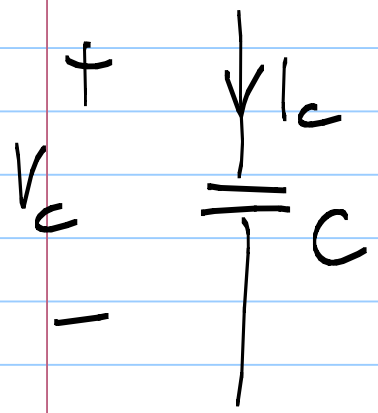
$$P_R = \frac{V_R^2}{R}$$

$$E_R = \int_0^t P_R(t) \cdot dt$$


I
Passive
Passive
V·I ≤ 0
V·I ≥ 0
V
V·I ≥ 0
V·I ≤ 0
1
1
2
V

Capacitor:

$E_c \geq 0$: passive



$$I_c = C \cdot \frac{dV_c}{dt} \qquad P = C V_c \cdot \frac{dV_c}{dt}$$

$$= \frac{C}{2} \frac{d}{dt}\left(V_c^2\right)$$

t t_2

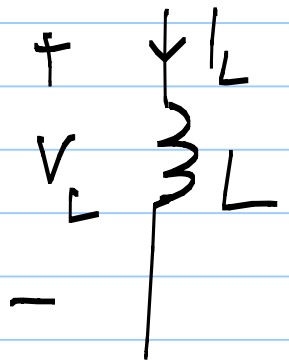
$$E_c = \int_{t_1}^{t_2} \frac{C}{2} \frac{d}{dt}\left(V_c^2\right) \cdot dt = \frac{C}{2}\left[V_c^2(t) - V_c^2(0)\right]$$

$V_c^2(t_2) - V_c^2(t_1)$

@ $t=0$ C is discharged

Inductor:

Passive

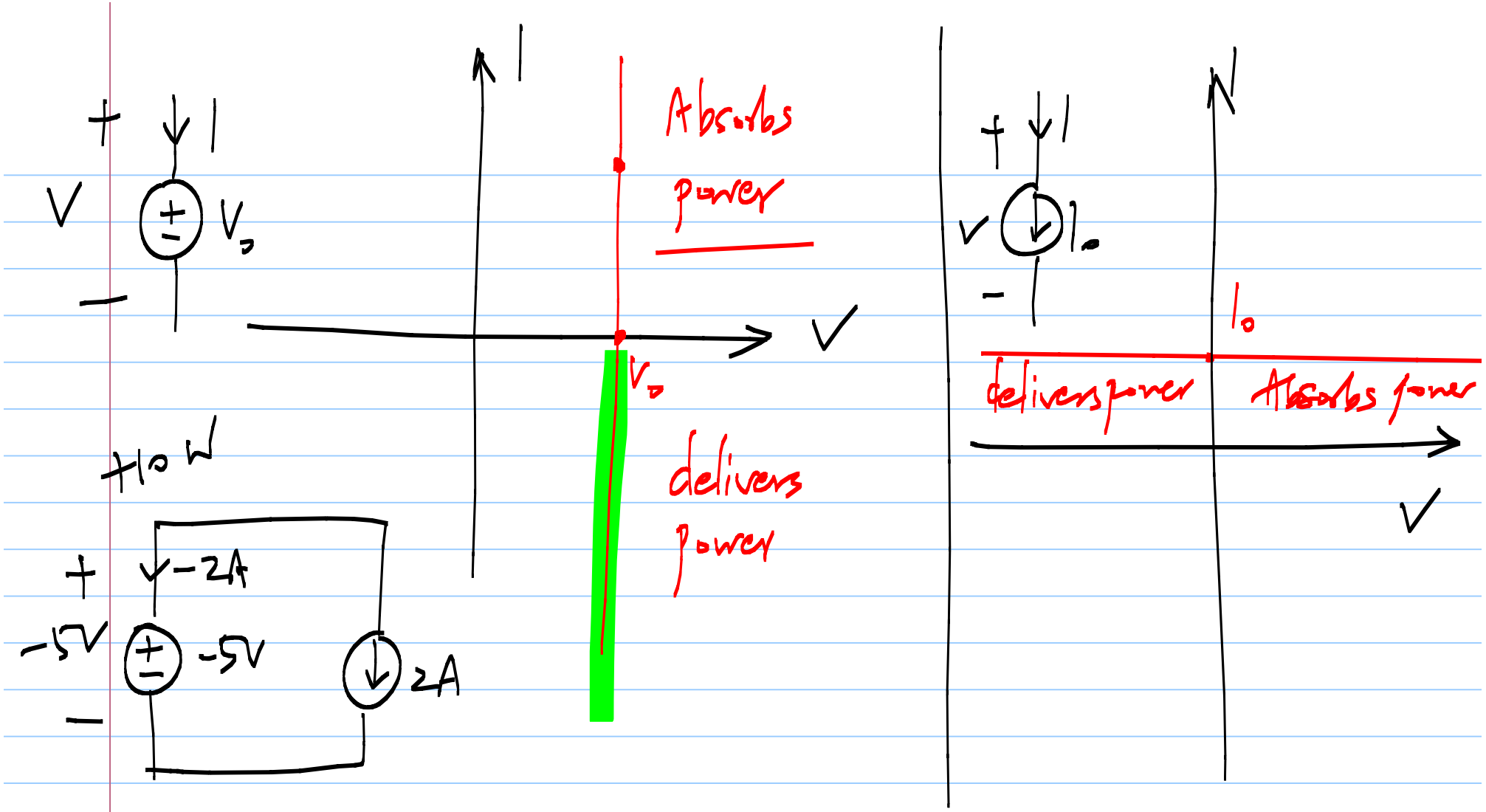


$$v_L = L \cdot \frac{di_L}{dt} \qquad p_L = L \cdot i_L \cdot \frac{di_L}{dt} = \frac{L}{2}\frac{d}{dt}\left(i_L^2\right)$$

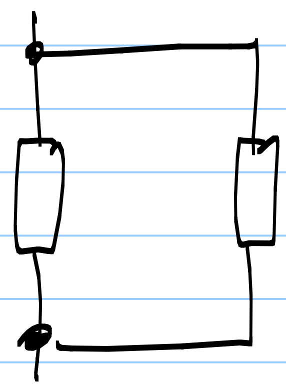
$$E_L = \int_{t_1}^{t_2} \frac{L}{2} \cdot \frac{d}{dt}\left(i_L^2\right) dt = \frac{L}{2}\left(i_L^2(t_2) - i_L^2(t_1)\right)$$

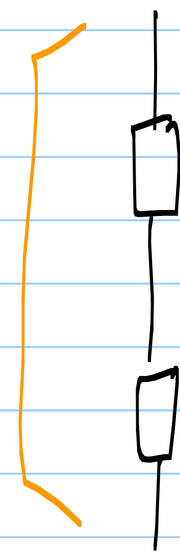
Stored energy in an inductor: $\frac{1}{2} L i_L^2$

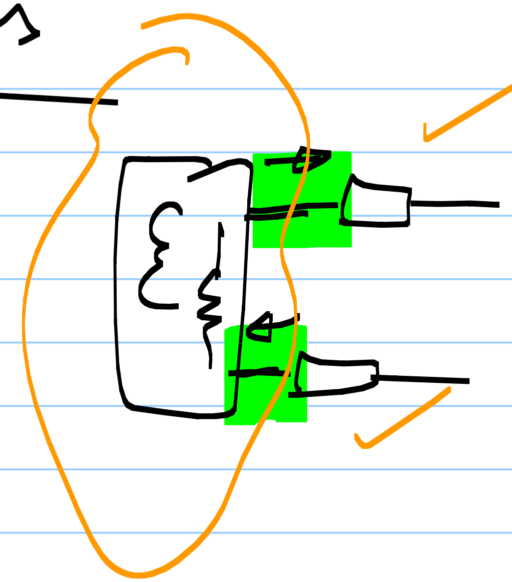
E_L

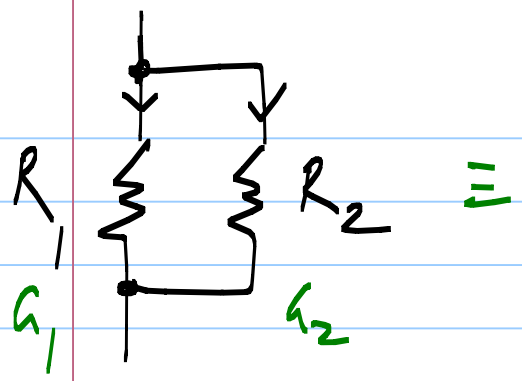

+
I
V
±
V_o
−
I
V
Absorbs power
V_o
delivers power
+10 W
+
V
−2A
−5V
−5V
±
2A
−
+
I
V
I_o
−
I
V
I_o
delivers power
Absorbs power

Elements in parallel & series





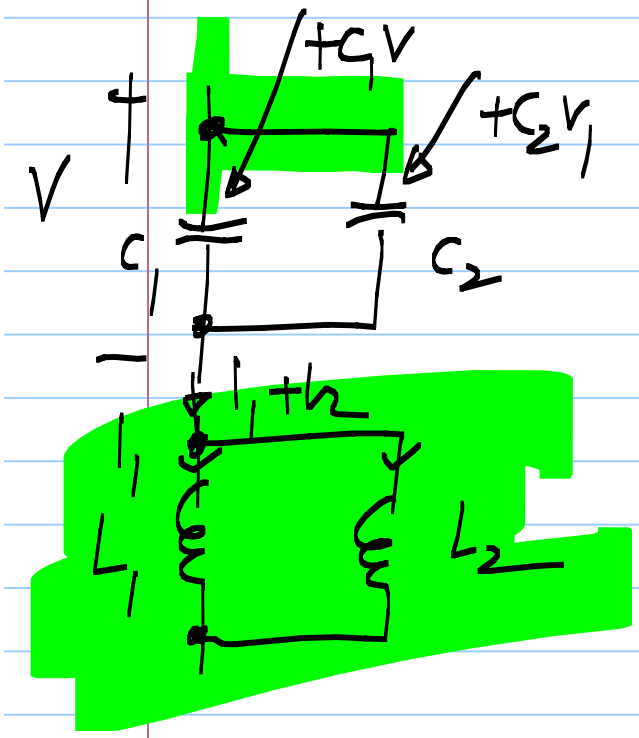




$\equiv$

$$R = \frac{R_1 R_2}{R_1 + R_2}$$

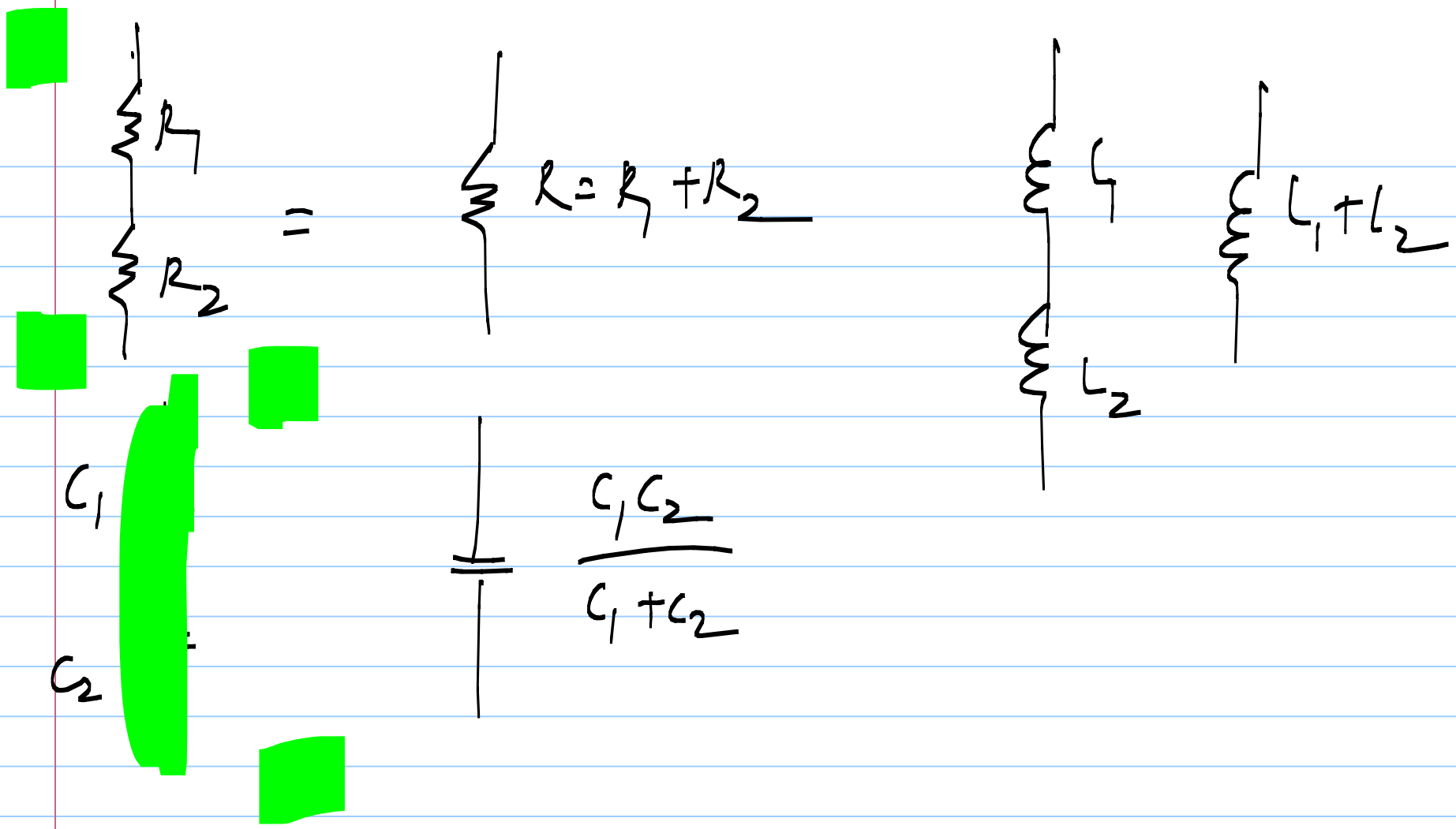
$$G = G_1 + G_2$$

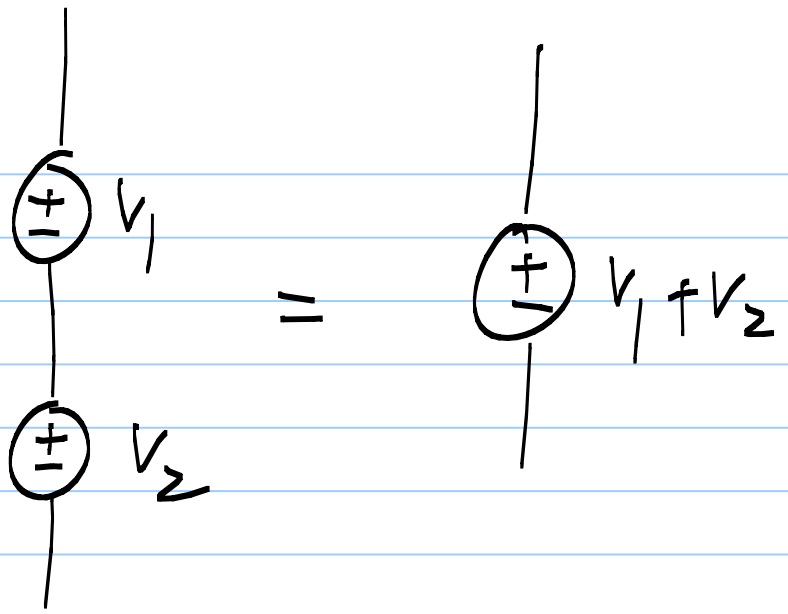


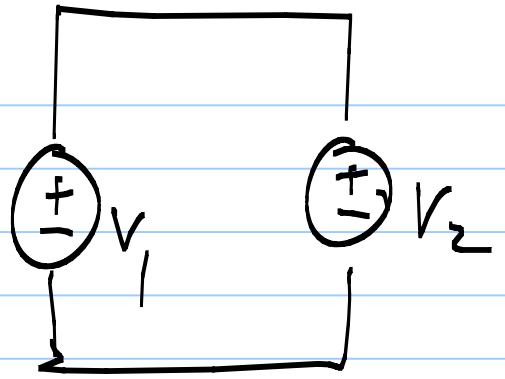
$$C = C_1 + C_2$$

$$\frac{L_1 L_2}{L_1 + L_2}$$

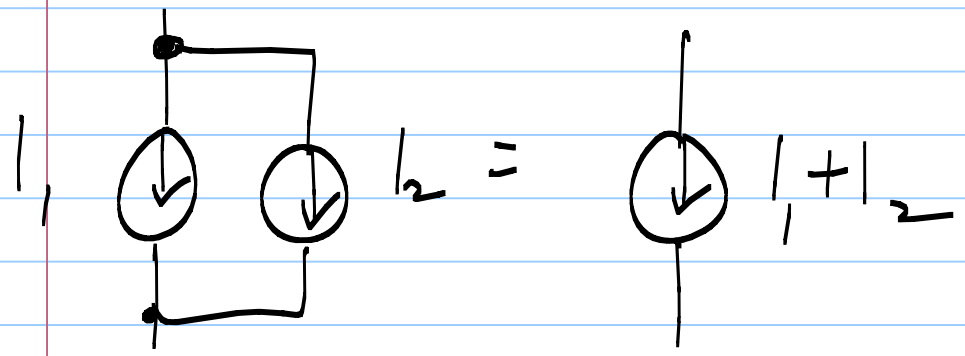
$$V_L = L_1 \frac{dI_1}{dt} = L_2 \frac{dI_2}{dt}$$

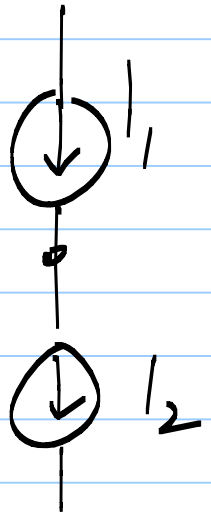

R1
R2
=
R = R1 + R2
L1
L2
L1 + L2
C1
C2
C1 C2
C1 + C2





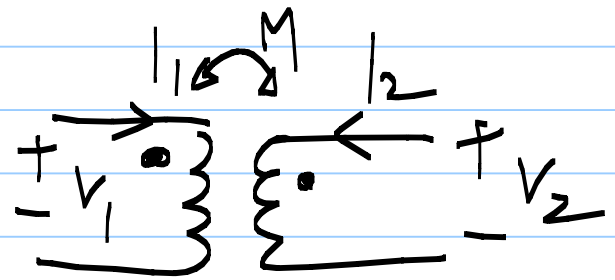
violates KVL if $V_1 \neq V_2$



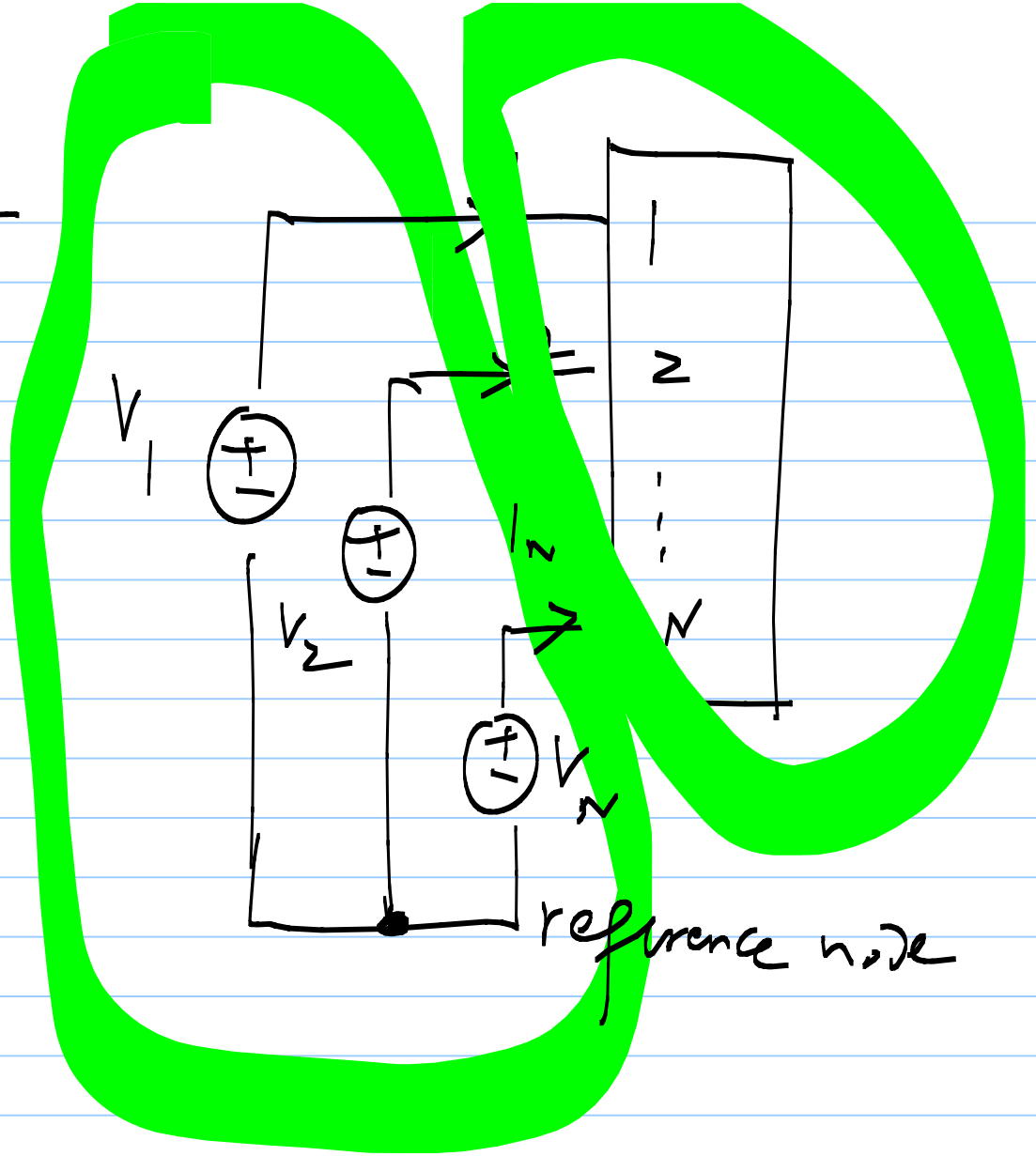


X violates KCL if $I_1 \neq I_2$

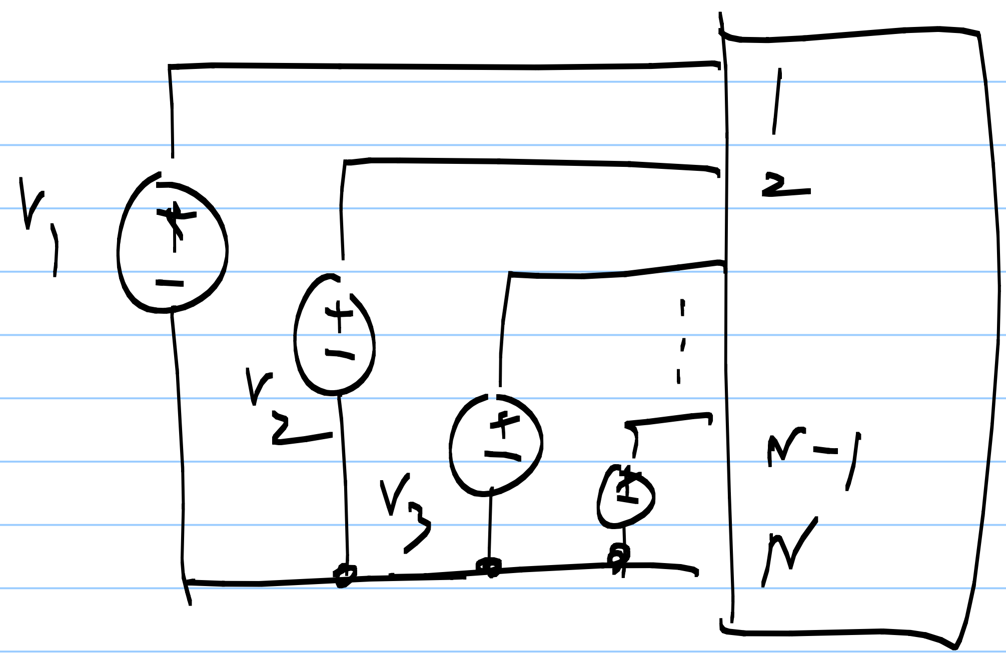
Mutual inductance



$$\sum_{k=1}^{N} V_k I_k$$



Choose $V_N = 0$



$$\sum_{k=1}^{N-1} V_k I_k$$