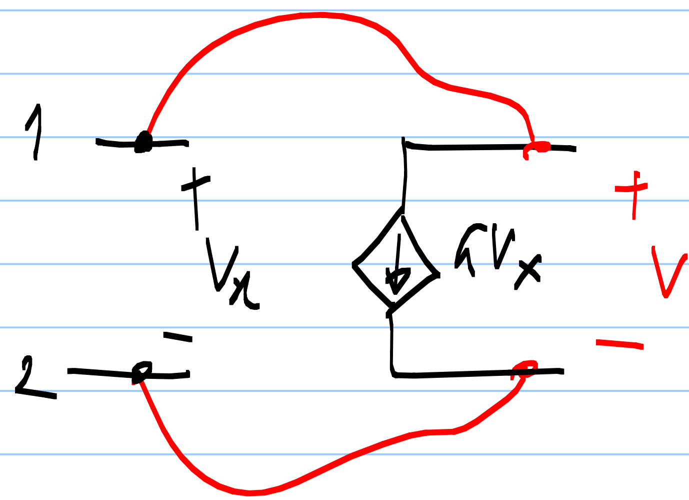
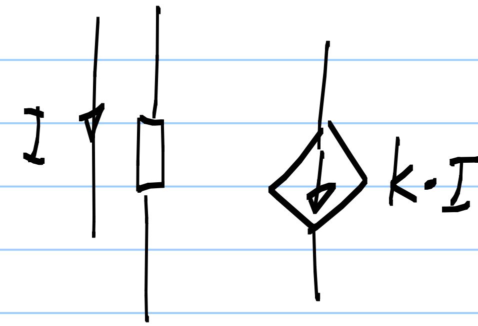
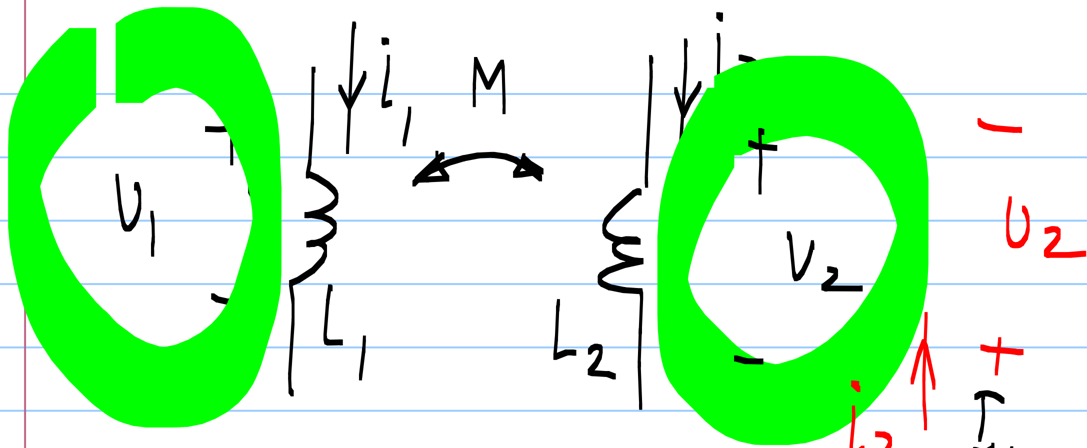
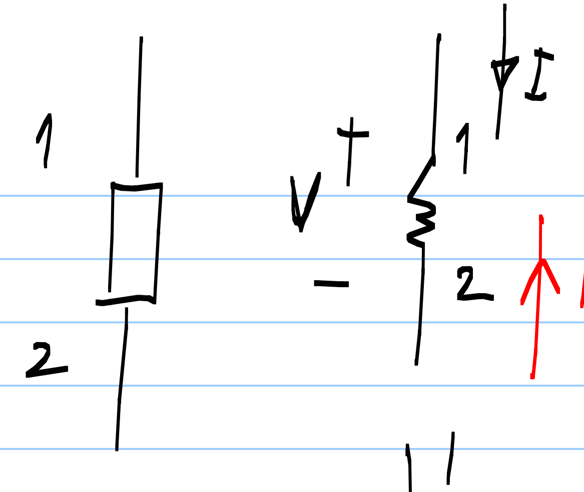
Lecture #4

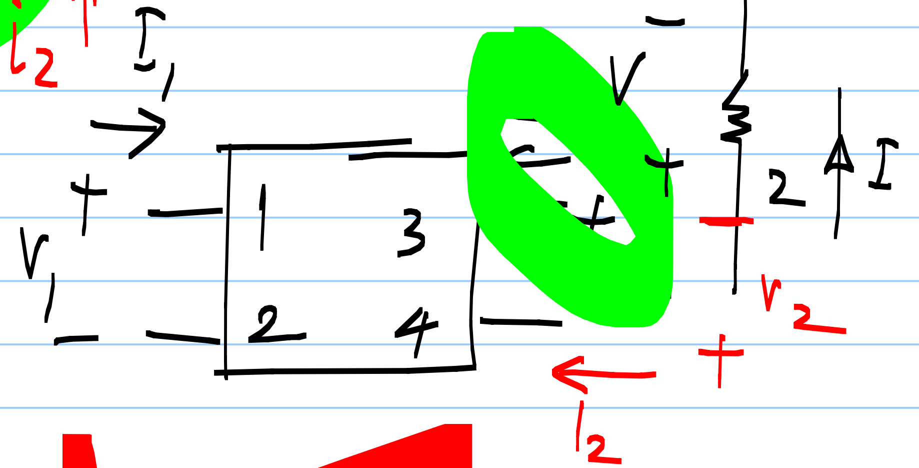
Voltage dependent source





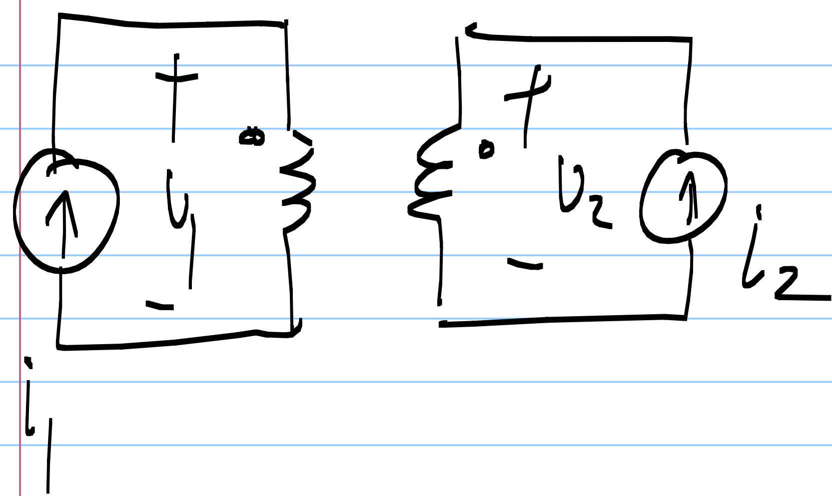


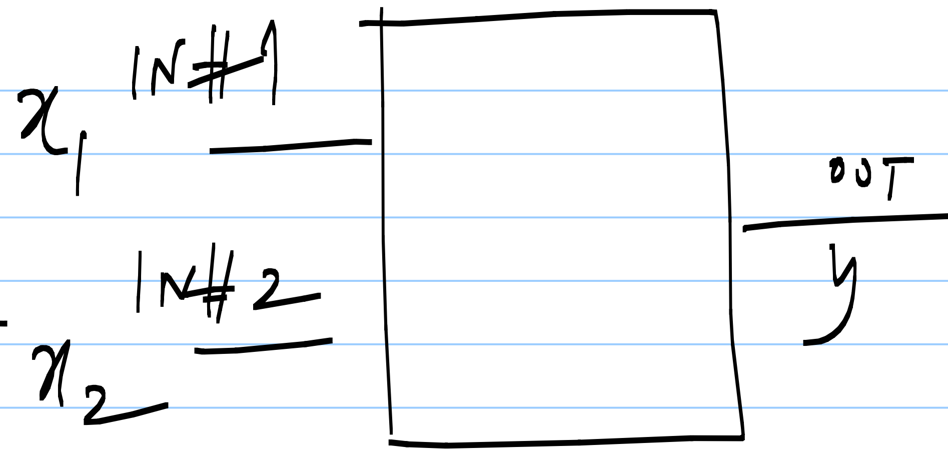


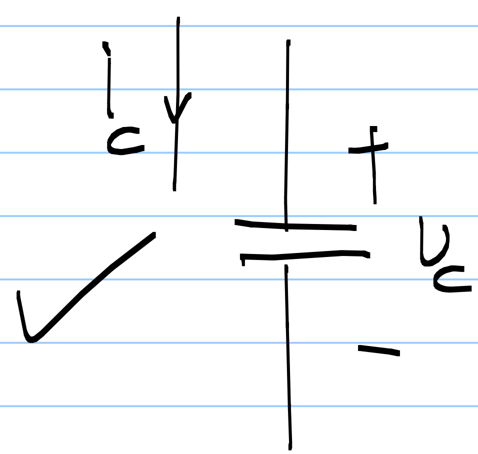


$$U_1 = L_1 \cdot \frac{di_1}{dt} + M \cdot \frac{di_2}{dt}$$

$$U_2 = M \cdot \frac{di_1}{dt} + L_2 \cdot \frac{di_2}{dt}$$



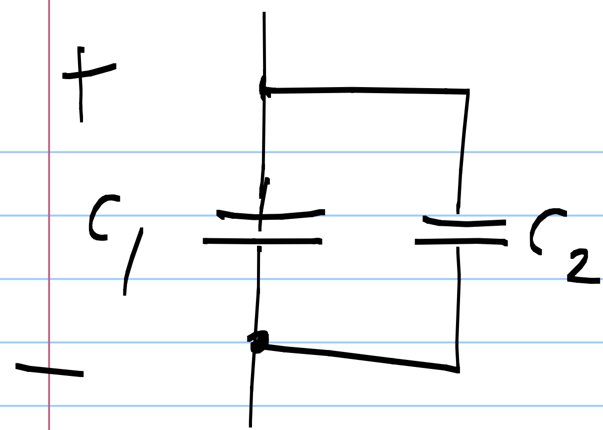




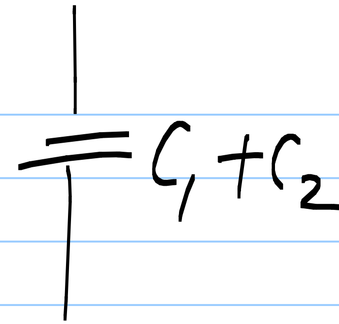
$$i_c = C \cdot \frac{dv_c}{dt}$$

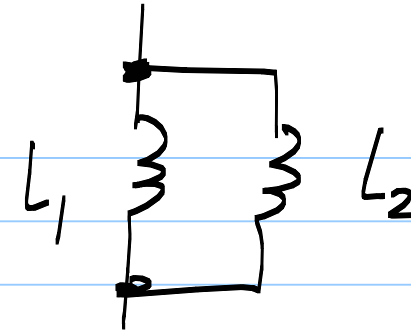
$$\frac{dv_{c_1}}{dt}, \frac{dv_{c_2}}{dt}$$

$$\frac{d}{dt}(v_{c_1} + v_{c_2})$$

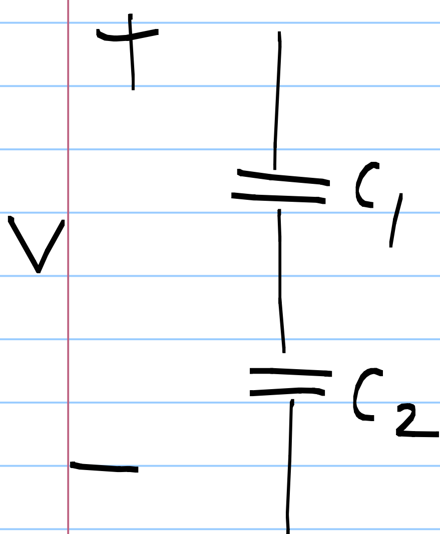


$\equiv$





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



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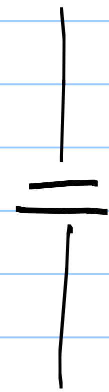
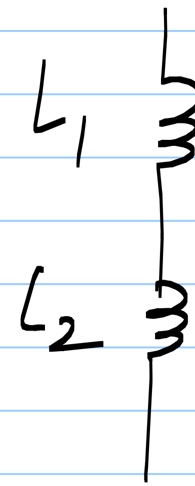
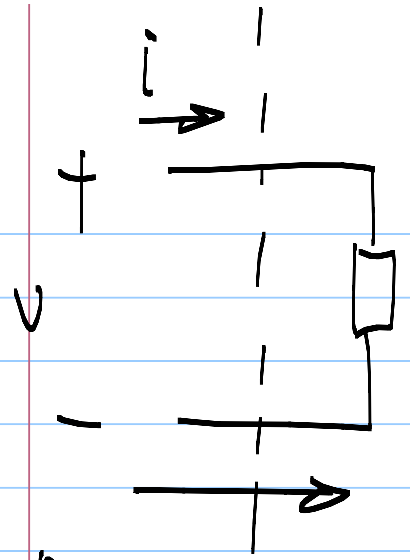


$$\frac{C_1 C_2}{C_1 + C_2}$$



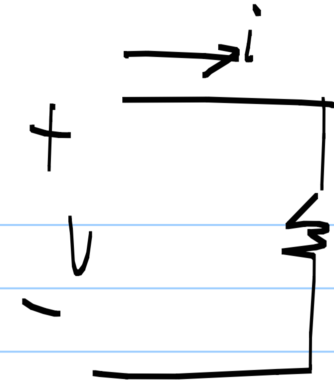
$$\equiv L_1 + L_2$$



Power going into this port = $v \cdot i$

$p(t) = v \cdot i$

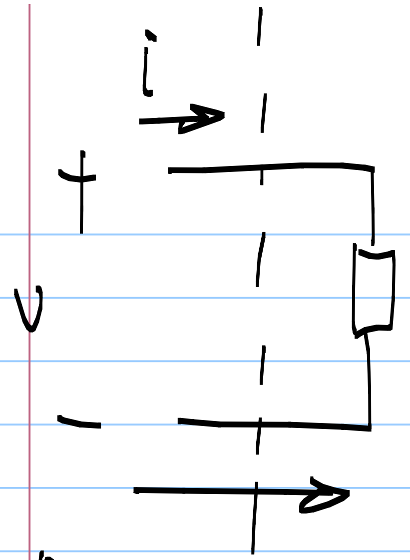
$$E = \int_0^t v(t) \cdot i(t) \cdot dt$$



$v = iR$

$p = v^2 / R = i^2 \cdot R$

Always dissipates power



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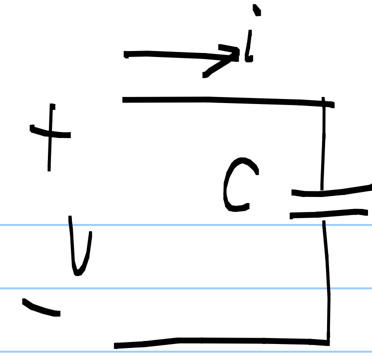


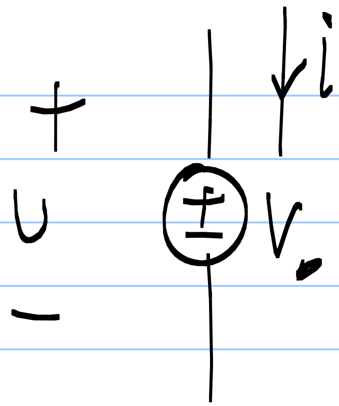
$i = C \cdot \frac{dv}{dt}$

$$P = Cv \cdot \frac{dv}{dt} = \frac{d}{dt}\left(\frac{Cv^2}{2}\right)$$

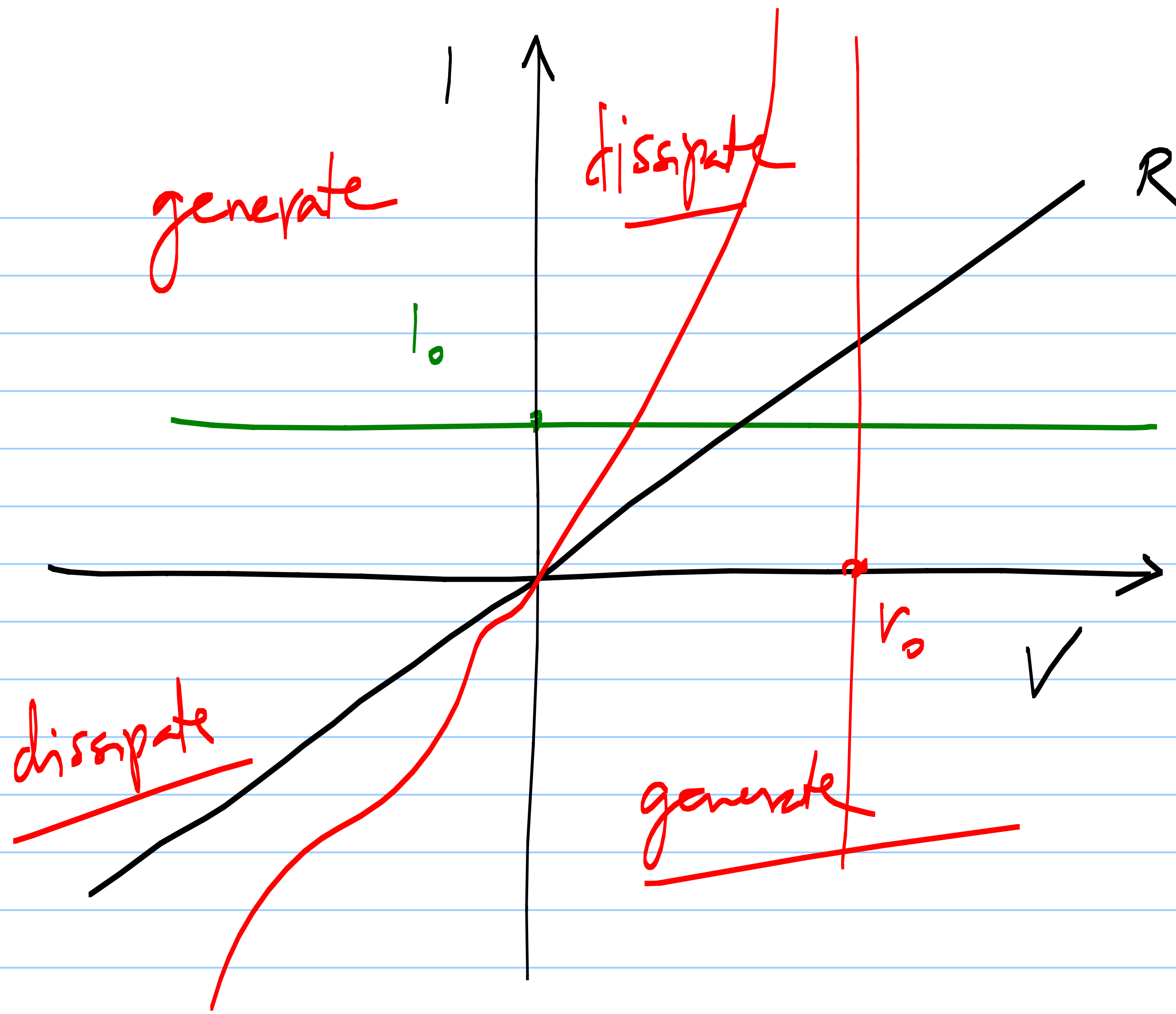
$$E = \frac{Cv^2}{2}$$ (Stored in the capacitor)

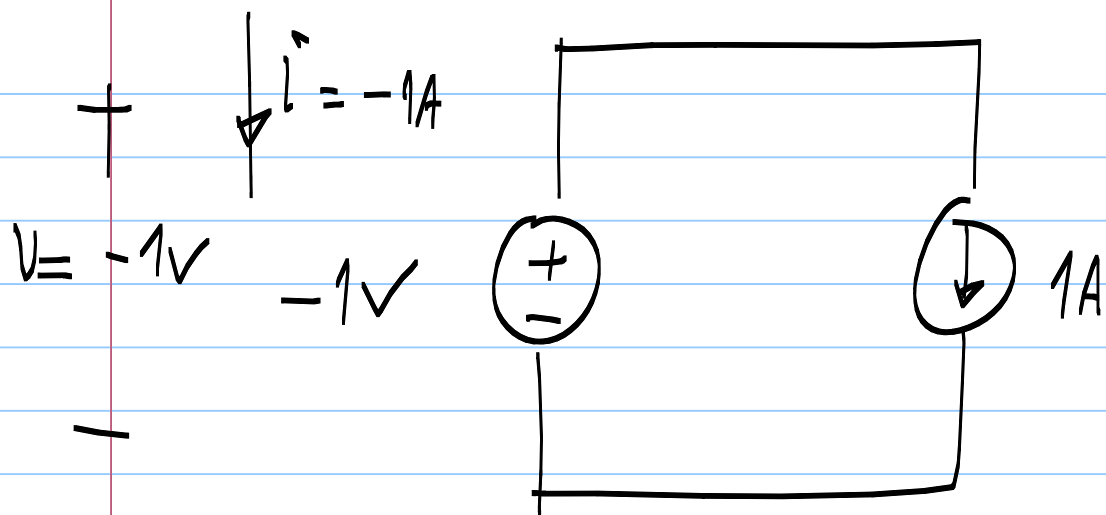
$$P_L = Li\frac{di}{dt} = \frac{d}{dt}\left(\frac{Li^2}{2}\right)$$

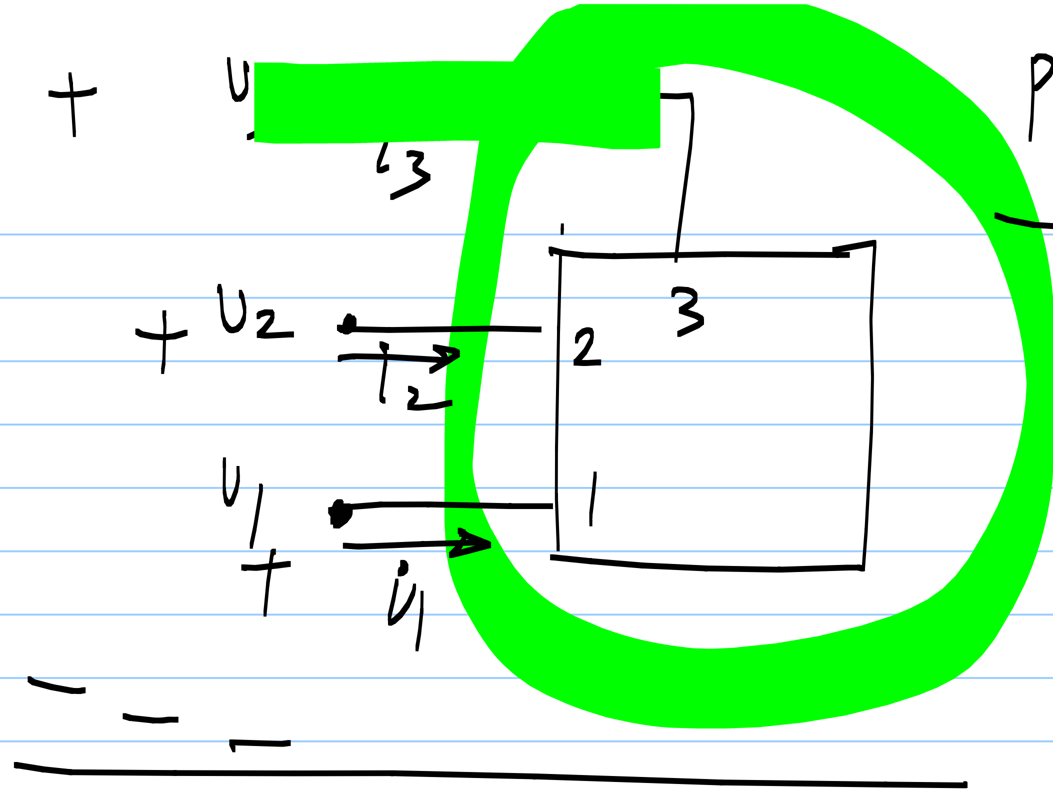
E



$V_0 \cdot i$




+
$i = -1A$
$v = -1V$
$-1V$
+
−
1A
−



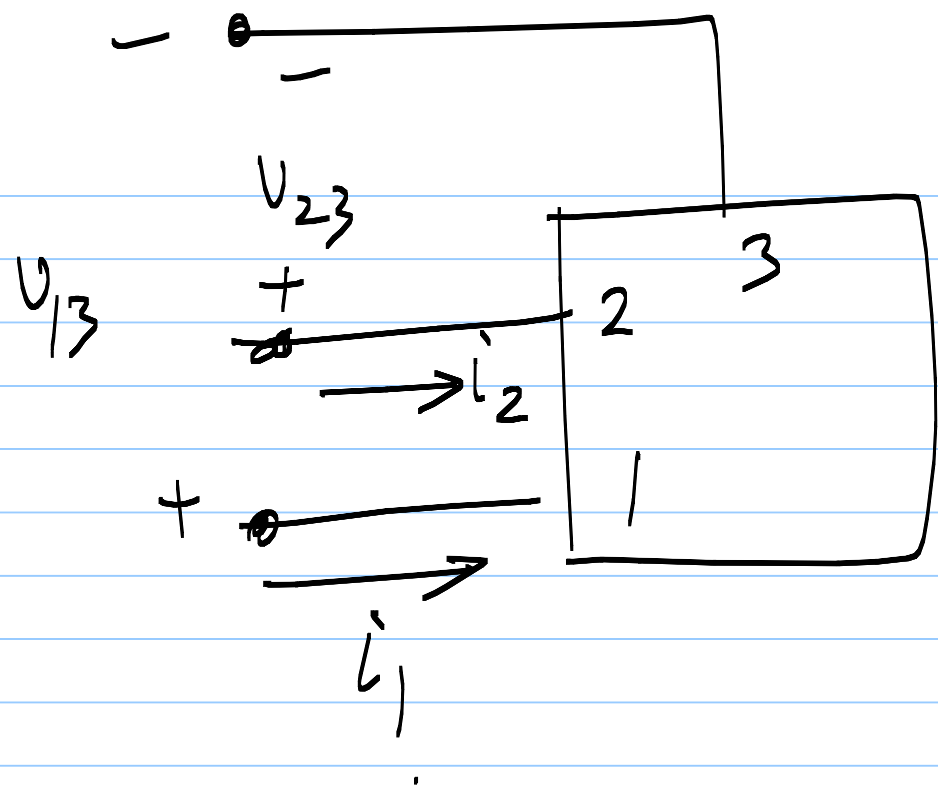
$$P = v_1 i_1 + v_2 i_2 + v_3 i_3$$

$$i_1 + i_2 + i_3 = 0$$

$$i_3 = -i_1 - i_2$$

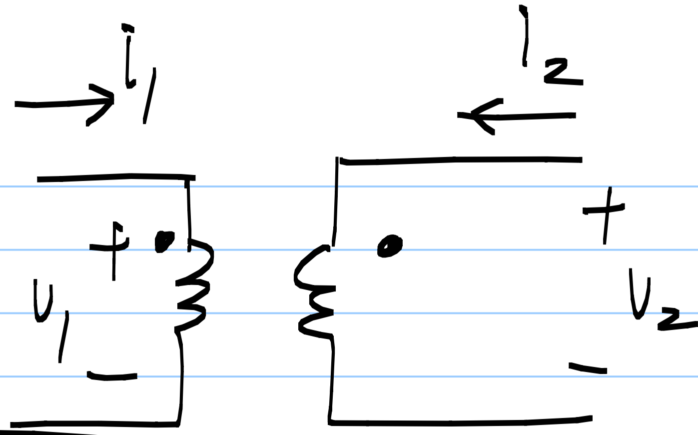
$$P = v_1 i_1 + v_2 i_2 + v_3 (-i_1 - i_2)$$

$$= (v_1 - v_3) i_1 + (v_2 - v_3) i_2$$



$$p = v_{13} i_1 + v_{23} i_2$$

Total power input to the 3 terminal circuit



$$i_2 = -\frac{M}{L_2} i_1$$

$$p = v_1 i_1 + v_2 i_2$$

$$= L_1 i_1 \frac{di_1}{dt} + M i_1 \frac{di_2}{dt} + M i_2 \frac{di_1}{dt} + L_2 i_2 \frac{di_2}{dt}$$

$$= \frac{d}{dt}\left(\frac{L_1 i_1^2}{2} + \frac{L_2 i_2^2}{2} + M i_1 i_2\right)$$

Energy

$$E\Big| = \left(L_1 - \frac{M^2}{L_2}\right) \cdot \frac{i_1^2}{2}$$

$$i_2 = -\frac{M}{L_2} i_1$$