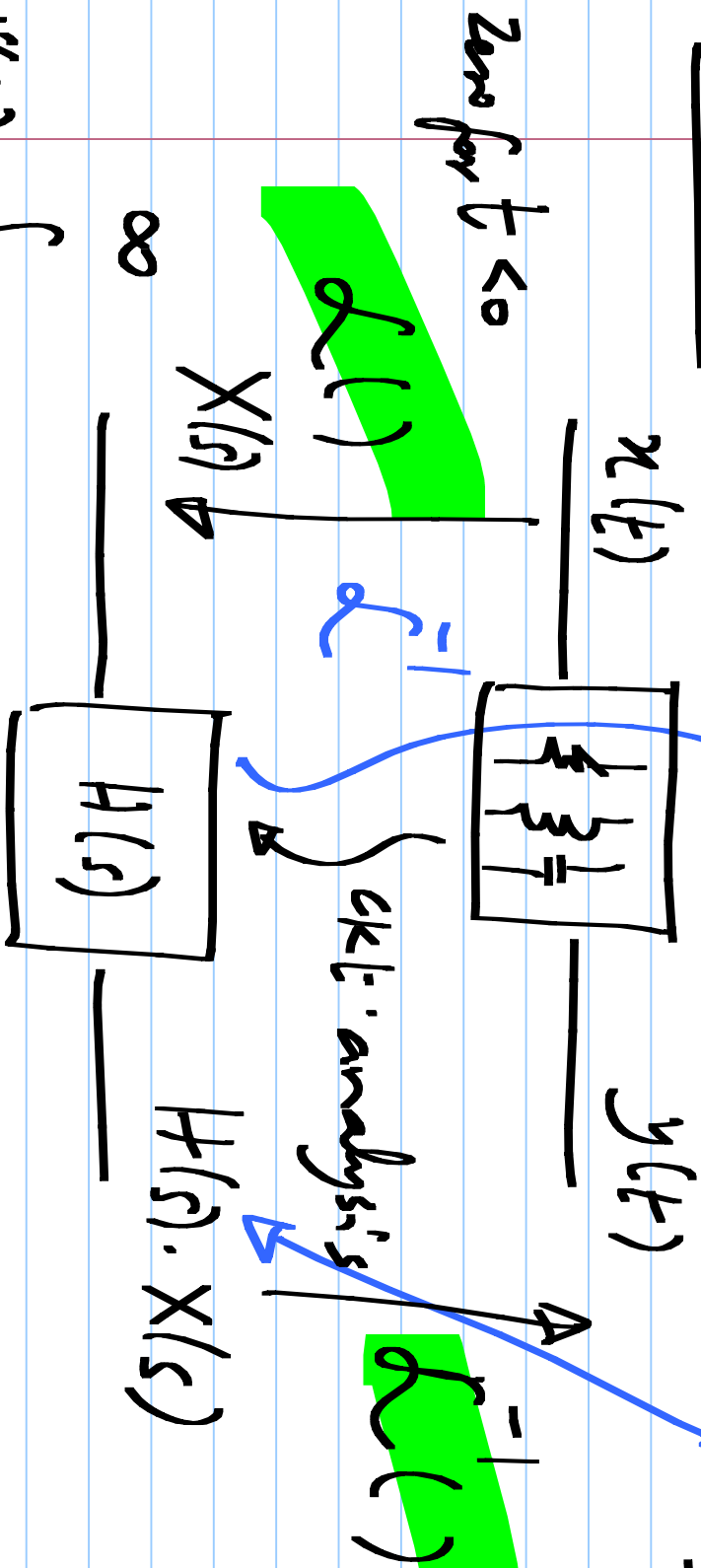


ECE 2015

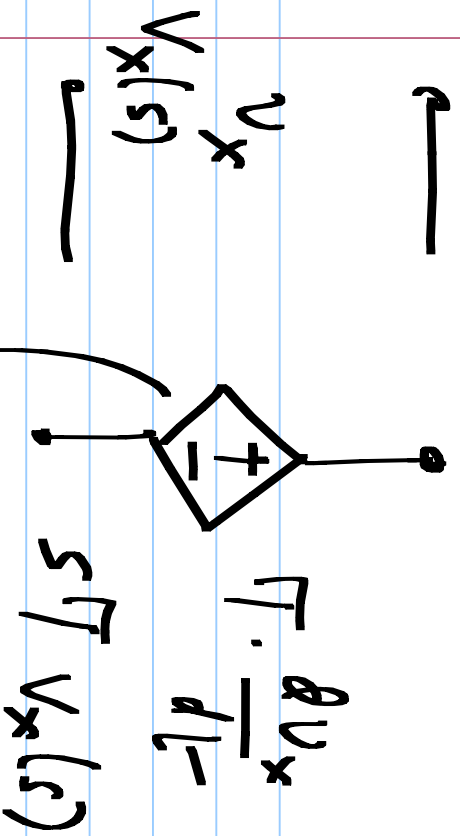
$$h(t) = \int x(t-\tau) h(\tau) \cdot d\tau$$

8/11/2017



$$X(s) = \int_{-\infty}^{\infty} x(t) \exp(-st) \cdot dt$$

unilateral Laplace transform



$$G(s) = \frac{1 + s/z_1}{(1 + s/p_1)(1 + s/p_2)}$$

Lumped R, L, C circuits  $(N(s))$

$$H(s) = \frac{b_m s^m + b_{m-1} s^{m-1} + \dots + b_1 s + b_0}{a_{n-1} s^{n-1} + \dots + a_1 s + a_0}$$

Roots of  $N(s)$ : Zeros

$(D(s))$

$$\text{Roots of } D(s) : p_1, p_2, \dots, p_N = k \frac{(s-z_1)(s-z_2)\dots(s-z_M)}{(s-p_1)(s-p_2)\dots(s-p_N)}$$

$$= \frac{r_1}{s-p_1} + \frac{r_2}{s-p_2} + \dots + \frac{r_N}{s-p_N}$$

$$r_1 + r_1^*$$

$$\frac{s - p_1}{s - p_1^*}$$

$$2\operatorname{Re}(r_1) \cdot s - 2\operatorname{Re}(r_1 p_1^*)$$

$$s^2 - 2\operatorname{Re}(p_1) \cdot s + |p_1|^2$$

$$= \frac{b_1 s + b_0}{s^2 + a_1 s + a_0}$$

$$\text{ex} (\sigma \cos \omega t + \phi)$$

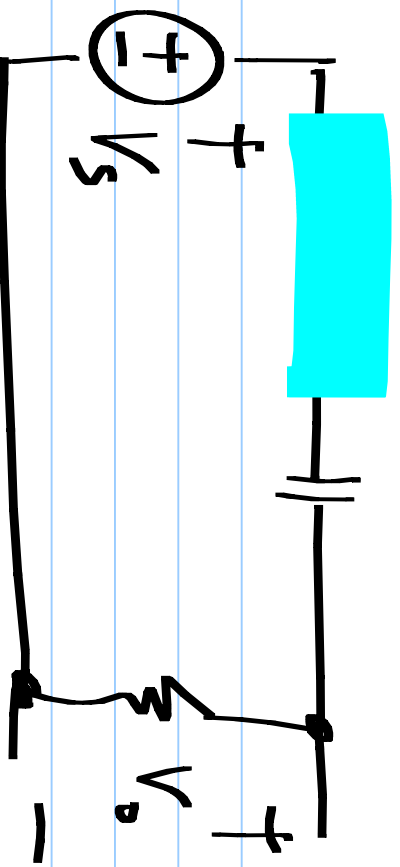
$$b_1 s + b_0$$

$$\frac{s^2}{s^2 + a_1 s + a_0}$$

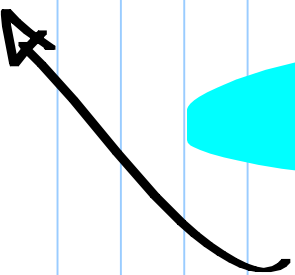
$$\cos \omega_s t: \frac{s^2 + \omega_0^2}{s}$$

$$= \frac{b_1 \left( s + \frac{a_1}{2} \right) + (b_0 - b_1 \frac{a_1}{2})}{(s + \frac{a_1}{2}) \left( \frac{a_1^2}{4} \right)} \exp\left(-\frac{a_1}{2} t\right) \cdot \cos \omega_s t:$$

$$\exp(-\frac{a_1}{2} t) \cos\left(\omega_s t\right) + (b_0 - b_1 \frac{a_1}{2}) \frac{1}{\omega_0^2} \exp\left(-\frac{a_1}{2} t\right) \sin\left(\omega_s t\right)$$

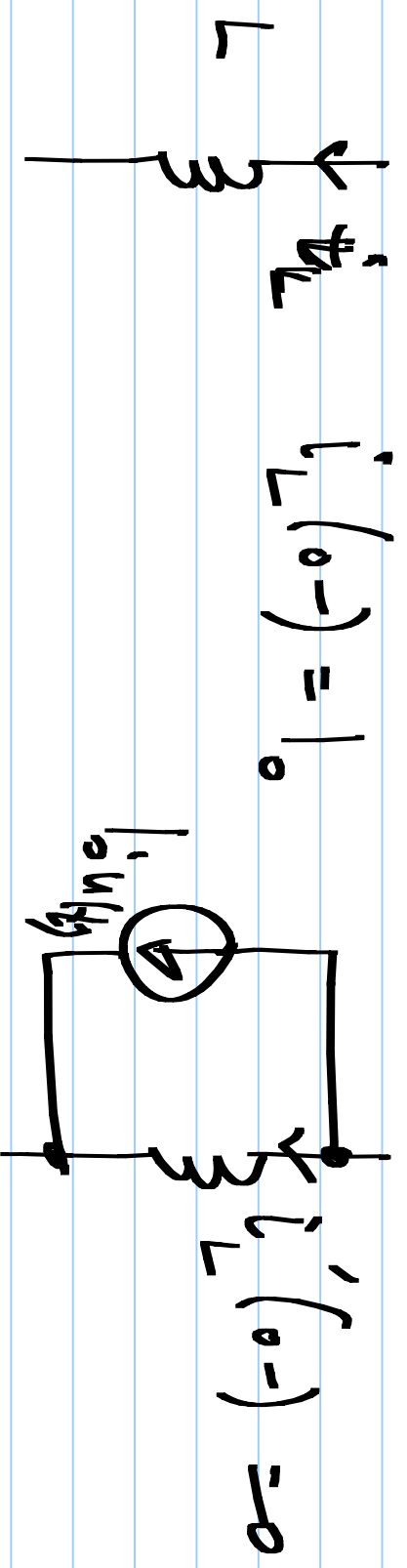
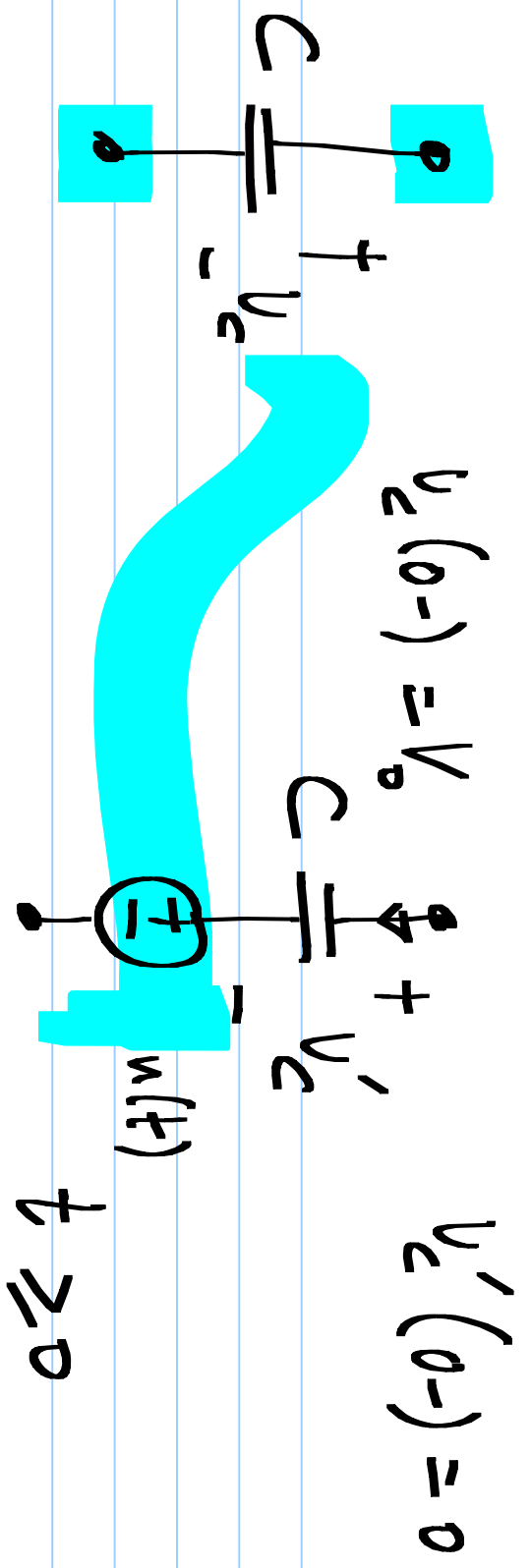


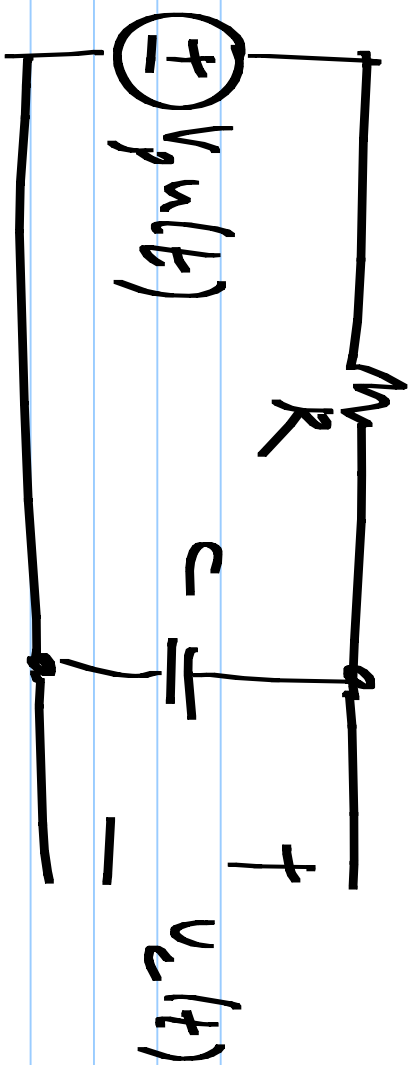
$= H(s)$



$+h, s$

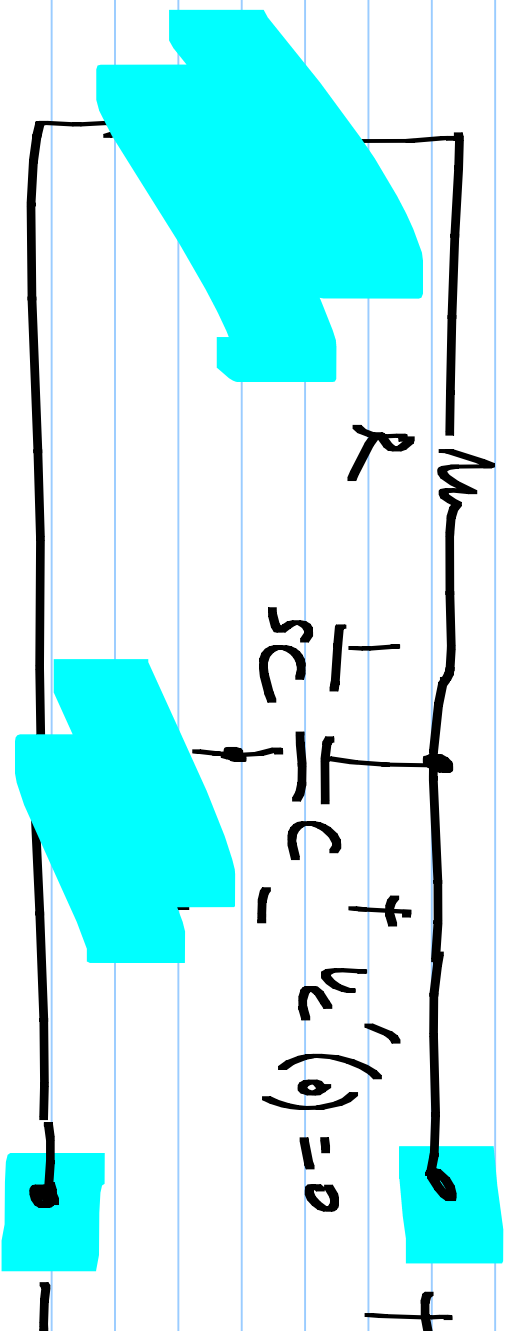
$D_2(s)$



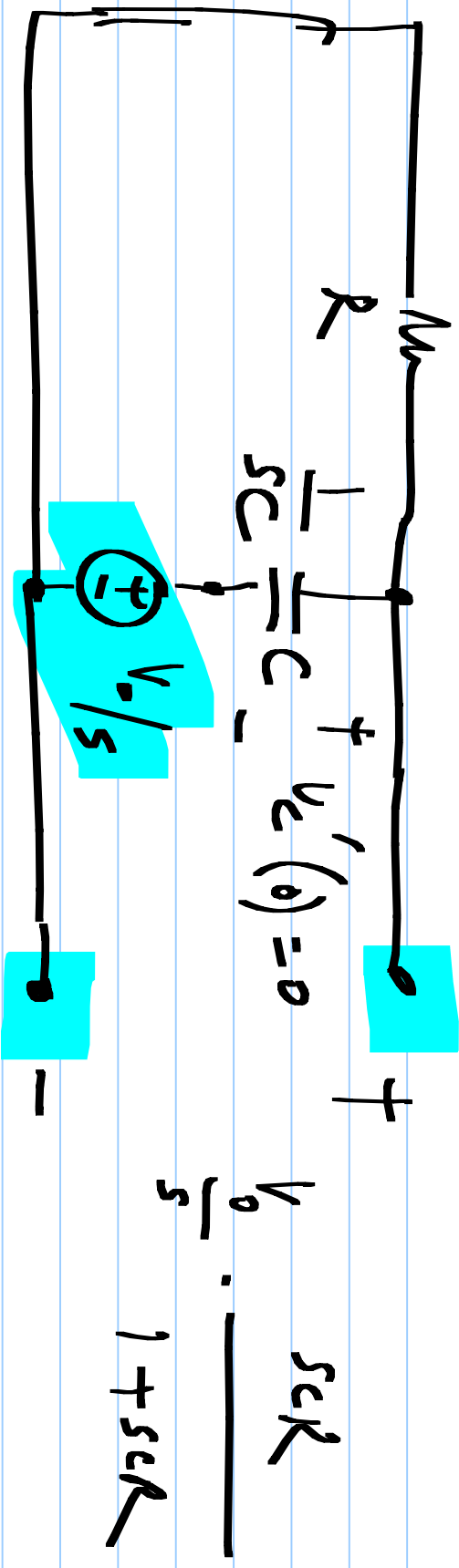
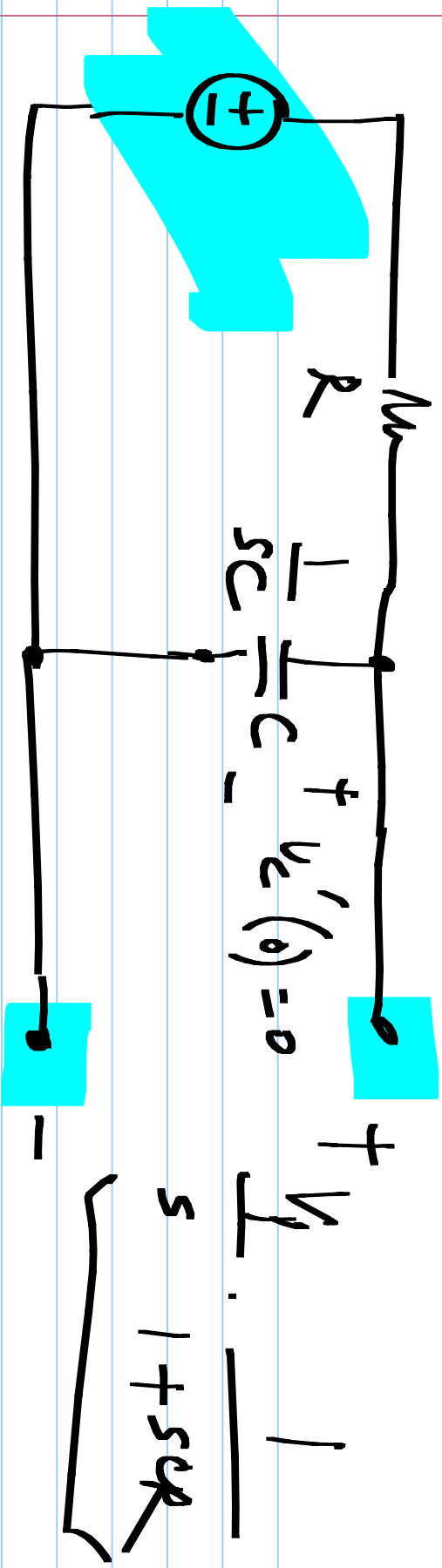


$$v_c(0^-) = V_p$$

$$v_c(t) : V_p + (V_0 - V_p) \exp(-t/Rc)$$







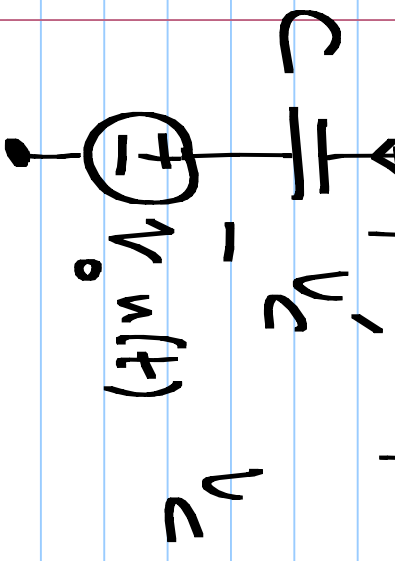
$$V_{\text{out}}(s) = \frac{V_p}{s} \cdot \frac{1}{1+sCR} + \frac{V_0}{s} \cdot \frac{sCR}{1+sCR}$$

$$= \frac{V_p}{s} - \frac{V_p \cdot \frac{1}{CR}}{1+s} + V_0 \cdot \frac{1}{1+s}$$

$\mathcal{L}^{-1}$   $\underbrace{\frac{1}{CR}}$

$$= v_p u(t) - v_p \exp\left(-\frac{t}{CR}\right) \cdot u(t) + v_0 \cdot \exp\left(-\frac{t}{CR}\right) u(t)$$

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



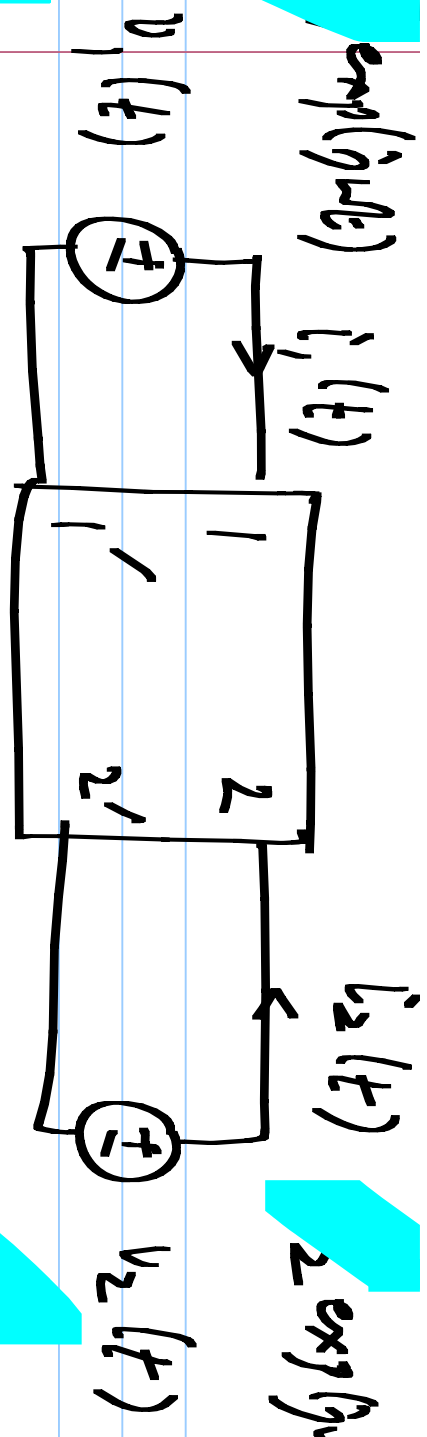
The diagram shows two parallel branches. The top branch contains a capacitor with current  $i_c$  flowing downwards and voltage  $v_c$  across it. The bottom branch contains a current source  $i_c'$  (represented by a circle with a plus sign) and a voltage  $v_c'$  across it. The two branches are connected in parallel between two nodes.

$$= sC \left( v_c(s) - \frac{v_0}{s} \right)$$

$$= sC v_c(s) - C v_0$$

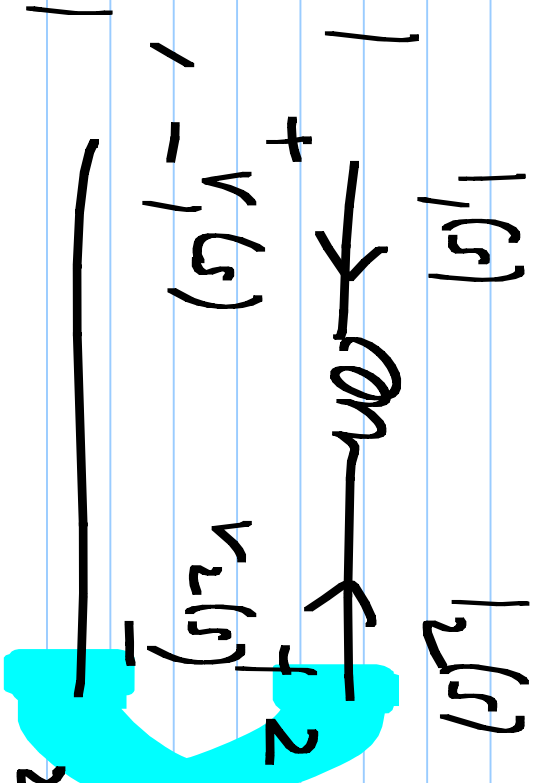
$$y = \frac{dx}{dt} \quad \underline{Y(s) = sX(s) - x(0)}$$

$z_1$  explicit)  $i_1(t)$   $z_2$  explicit)

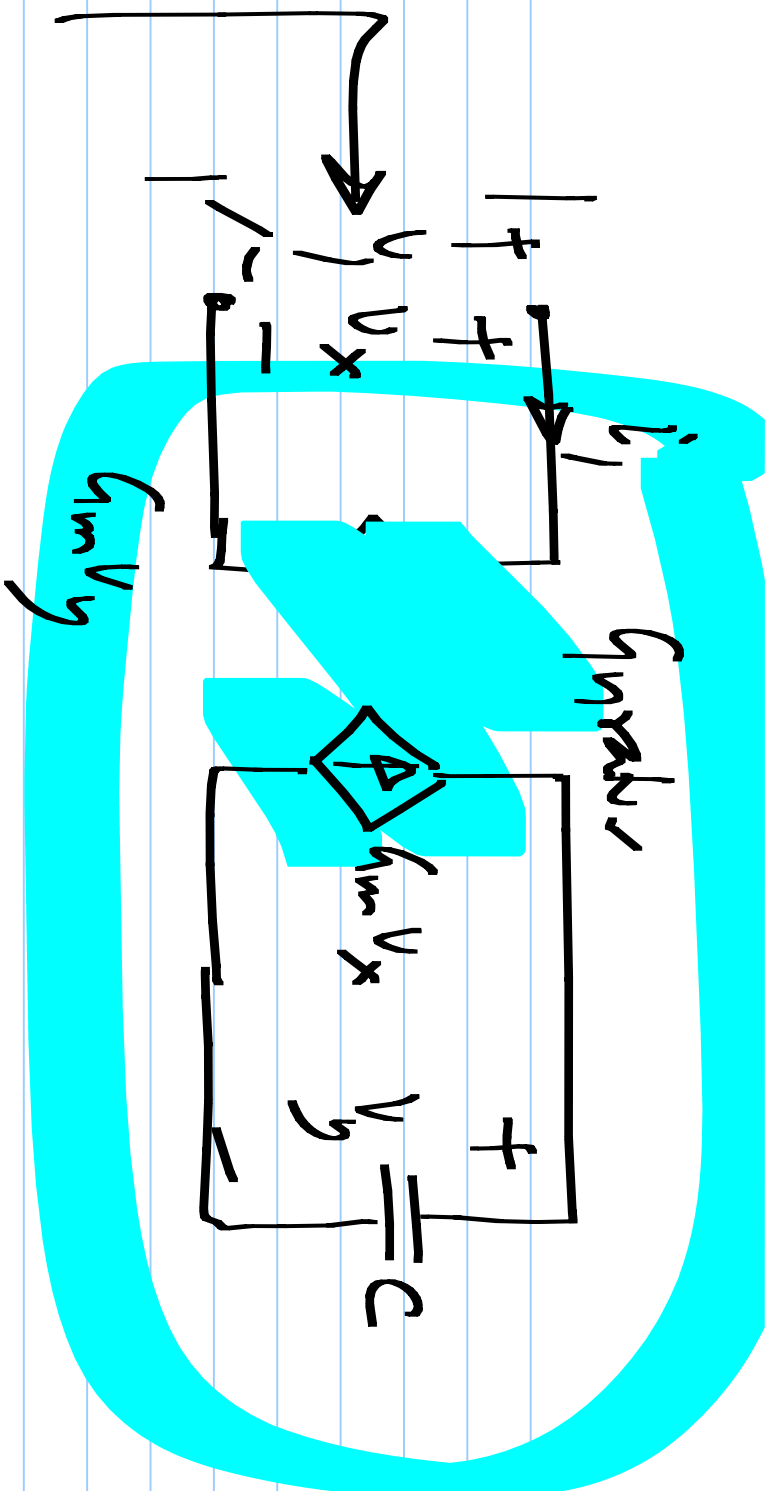


$V_1$  explicit)

$z_2$  explicit)



$$\begin{bmatrix} \frac{1}{sL} & -\frac{1}{sL} \\ -\frac{1}{sL} & \frac{1}{sL} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$



$$\equiv \frac{C}{g_m}$$

$$v_1 = \frac{C}{g_m} \cdot \frac{di_1}{dt}$$