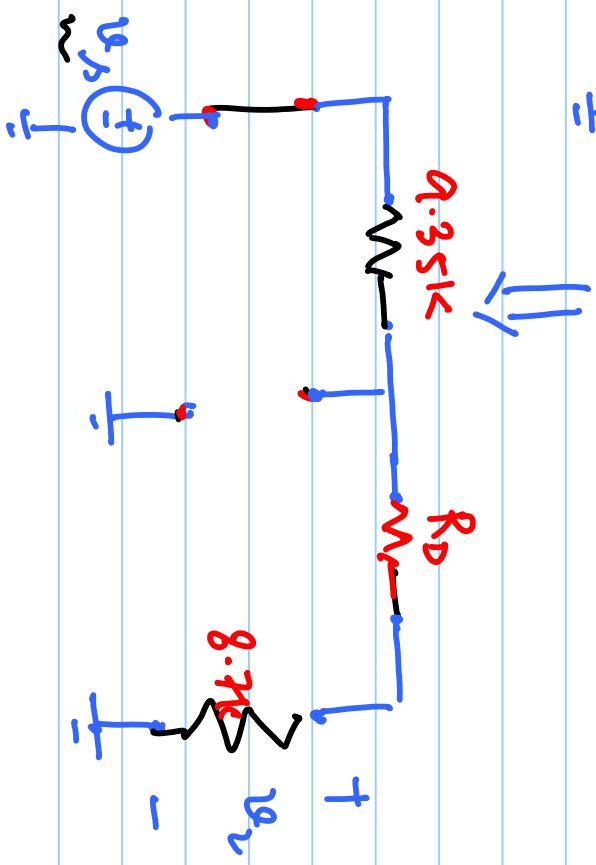
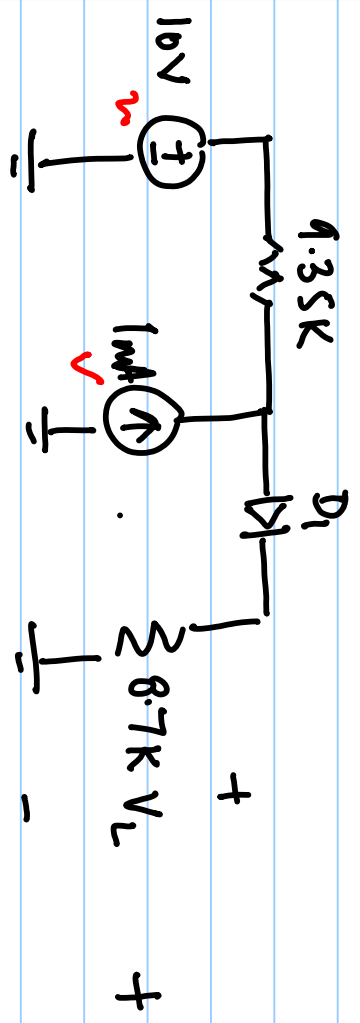
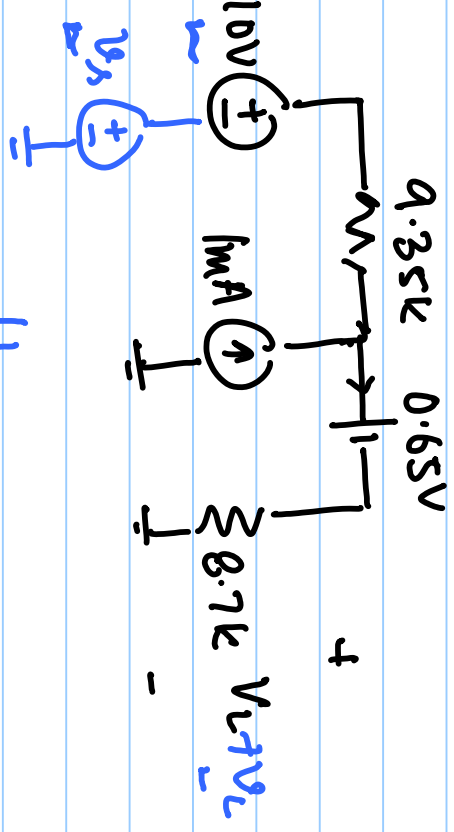
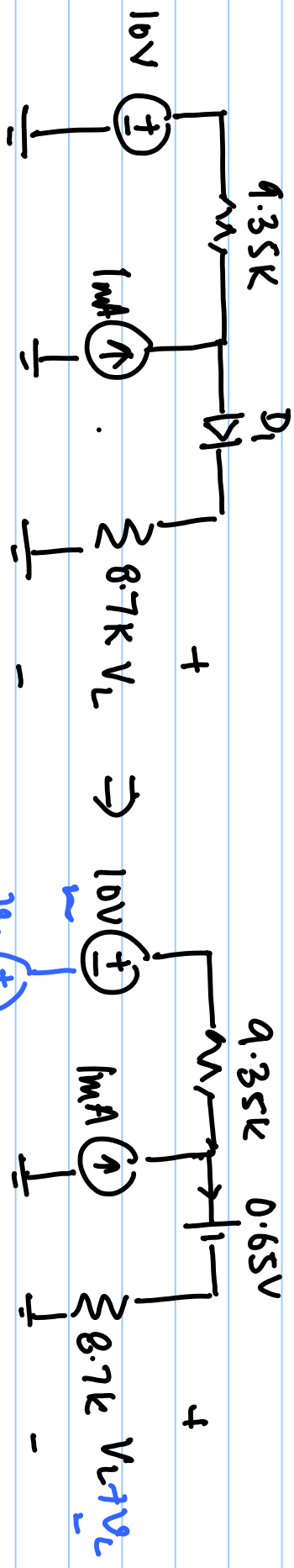
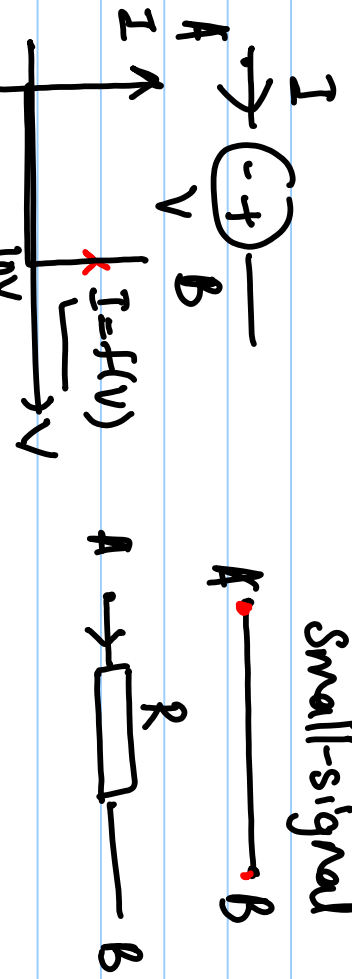


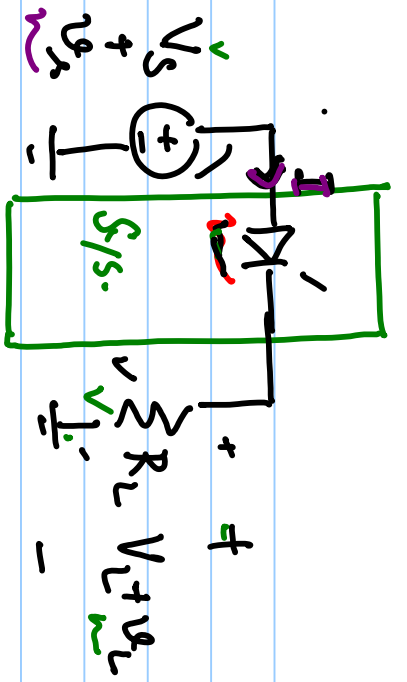
# Lecture # 5



Small-signal



$$R = \frac{1}{f'(V)} = \infty \text{ ; } 0$$

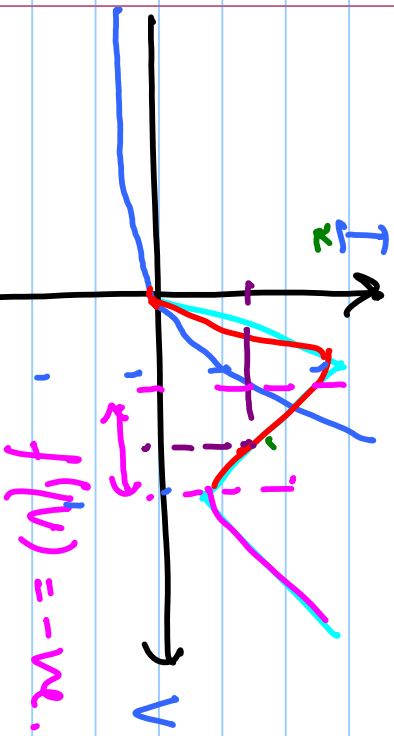


$$\frac{V_L}{V_s} = \frac{R_L}{R_L + R_D}$$

$$; R_D = \frac{V_T}{I}$$

$$\left| \frac{V_L}{V_s} \right| < 1$$

If  $\left| \frac{V_L}{V_s} \right| > 1 \Rightarrow R_D = -w = \frac{1}{f'(V)} \Rightarrow f'(V) = -w$

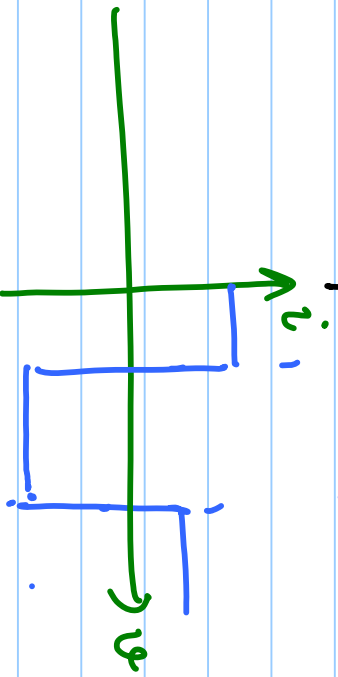


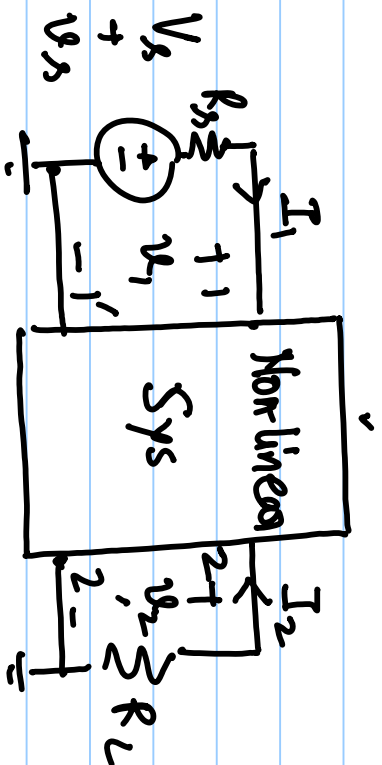
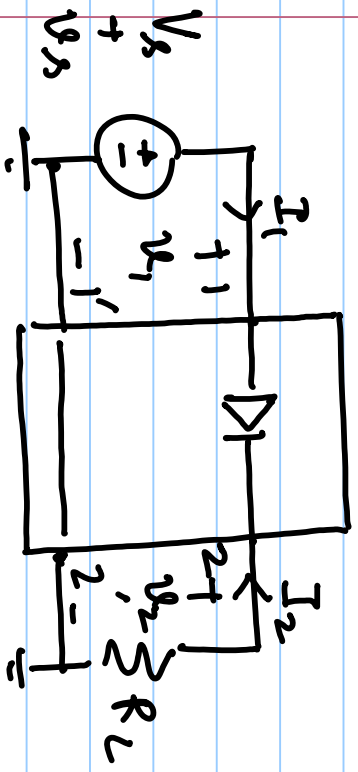
$$P_{in} = i \cdot V_s = \frac{V_s}{R_L - |R_D|} \cdot V_s$$

$$P_{out} = i \cdot V_L = \frac{V_s}{R_L - |R_D|} \cdot V_s \cdot \frac{R_L}{R_L - |R_D|}$$

$\left. \begin{matrix} P_{out} > P_{in} \\ \leftarrow \end{matrix} \right\}$

$$P_b = i \cdot (V_s - V_L) = \frac{V_s}{R_L - |R_D|} \cdot V_s \cdot \frac{-|R_D|}{R_L - |R_D|}$$





- DC operating point for a non-linear Sys.

- Small-signal analysis

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

To guess y-parameters for 2-port network for voltage gain.

$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \quad (1)$$

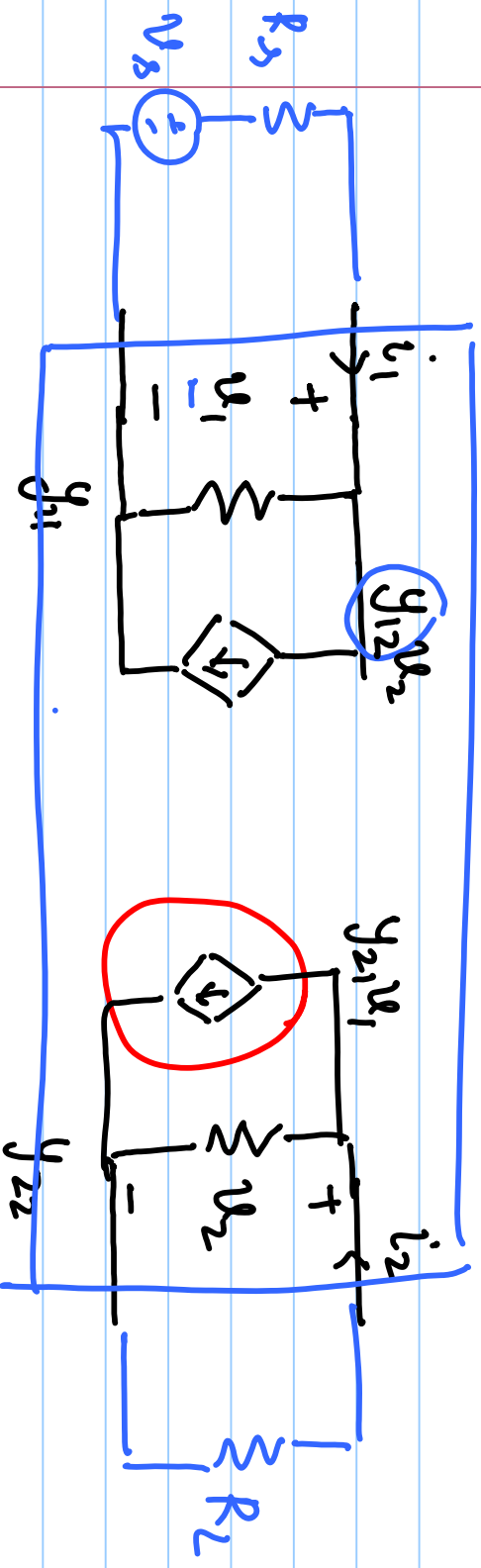
$$v_1 = v_s - i_1 \cdot R_s \quad (2)$$

$$v_2 = -i_2 \cdot R_L \quad (3)$$

$$\frac{v_2}{v_s} =$$

$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$\Rightarrow \begin{aligned} i_1 &= y_{11}v_1 + y_{12}v_2 \\ i_2 &= y_{21}v_1 + y_{22}v_2 \end{aligned}$$



$$R_L = \frac{v_L}{i_L} = \frac{-y_{21} / R_s}{\underbrace{\left( y_{11} + \frac{1}{R_s} \right) \left( y_{22} + \frac{1}{R_L} \right)}_{-y_{12} y_{21}} - y_{12} y_{21}}$$

$$= -y_{21} \cdot R_L$$

$$y_{11} : 0$$

$$y_{22} : 0$$

$$y_{12} : 0$$

$$y_{21} :$$

$$z = \frac{-y_{21} / R_s}{\frac{1}{R_s} \cdot \frac{1}{R_L} - \underbrace{y_{12} \cdot y_{21}}_{\rightarrow \epsilon'}} \rightarrow \infty$$

