

Remember Quiz 1 on Friday 1/16 at 10am - 10:20am

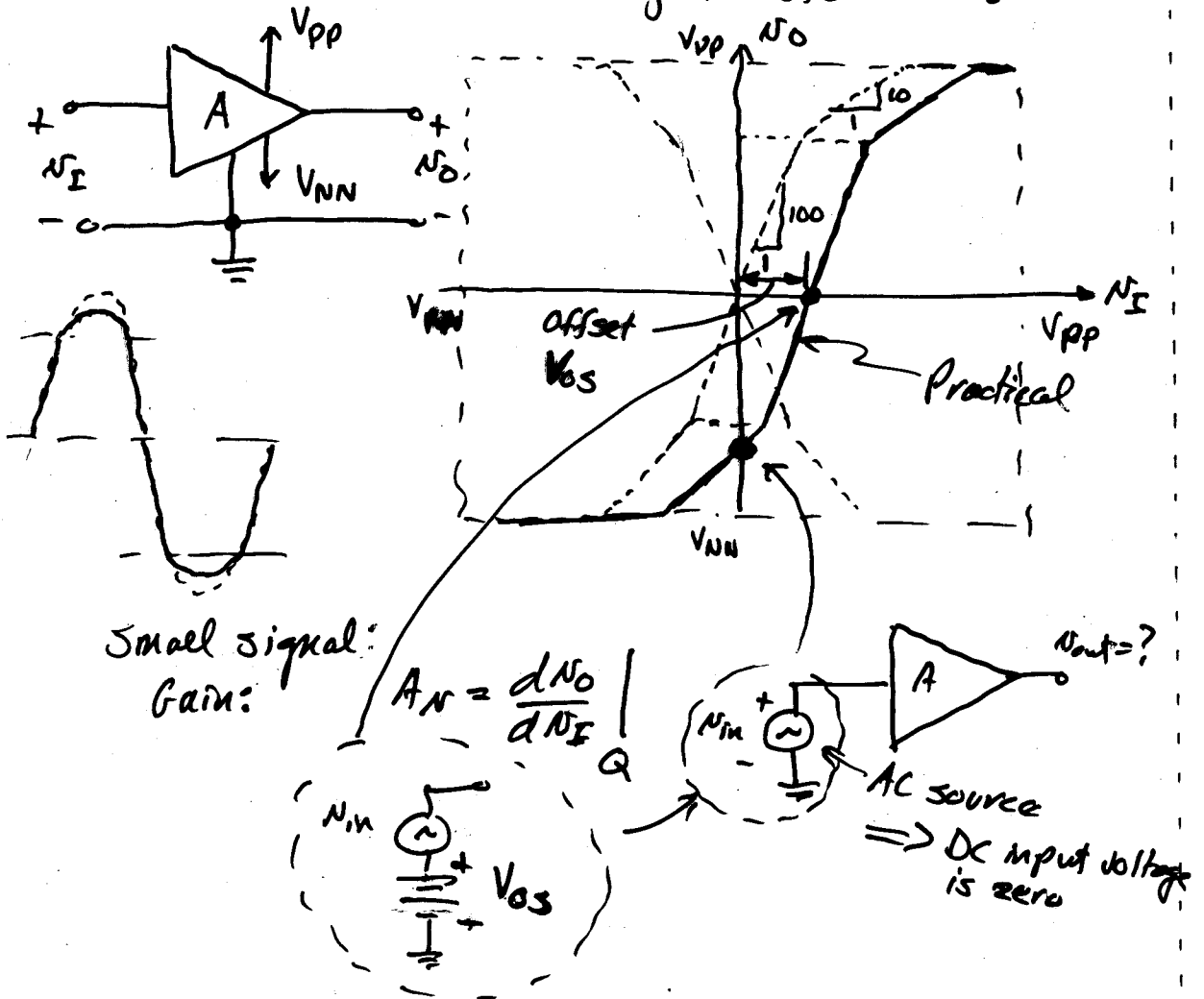
BJT: $i_c = I_s \exp\left(\frac{N_{BE}}{mV_{TH}}\right)$ $i_c = \beta_f i_b$

MOSFET: $i_D = \frac{K}{2} (N_{GS} - V_T)^2$ $N_{DS} \geq N_{GS} - V_T$

Diode: $i_D = I_s \exp\left(\frac{N_D}{mV_{TH}}\right) - I_s$

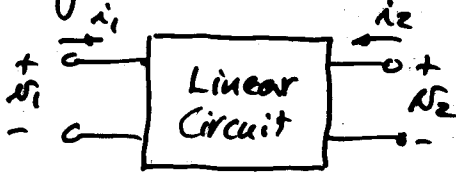
Amplifiers

Voltage transfer curve:



Two-Port Network Models for Linear Amplifiers

a.) *g*-parameters



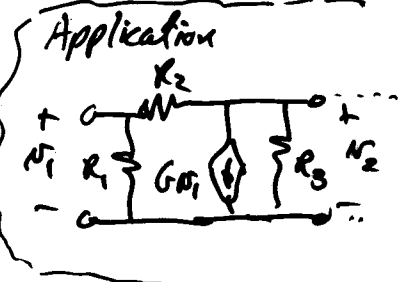
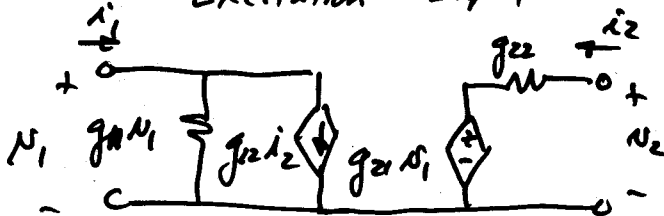
$$i_1 = g_{11}v_1 + g_{12}i_2$$

$$v_2 = g_{21}v_1 + g_{22}i_2$$

$$g_{11} = \left. \frac{i_1}{v_1} \right|_{i_2=0}, \quad g_{12} = \left. \frac{i_1}{i_2} \right|_{v_1=0}, \quad g_{21} = \left. \frac{v_2}{v_1} \right|_{i_2=0} \text{ and } g_{22} = \left. \frac{v_2}{i_2} \right|_{v_1=0}$$

Ratio?

$$\frac{\text{Response}}{\text{Excitation}} = \frac{\text{Output}}{\text{Input}}$$



b.) *h*-parameters

$$v_1 = h_{11}i_1 + h_{12}v_2$$

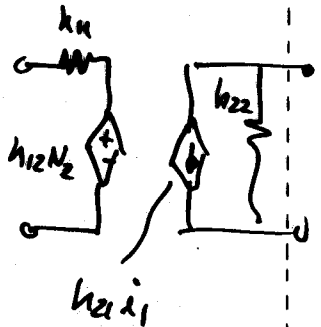
$$i_2 = h_{21}i_1 + h_{22}v_2$$

$$h_{11} = \left. \frac{v_1}{i_1} \right|_{v_2=0}$$

$$h_{12} = \left. \frac{v_1}{v_2} \right|_{i_1=0}$$

$$h_{21} = \left. \frac{i_2}{i_1} \right|_{v_2=0}$$

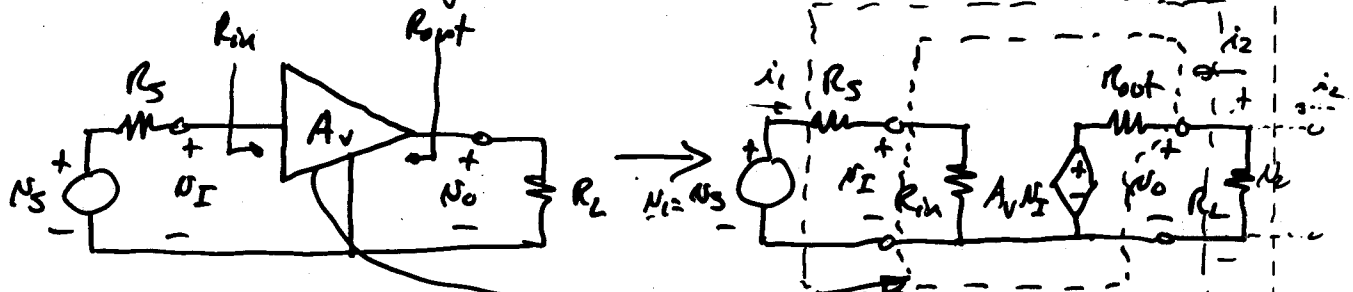
$$h_{22} = \left. \frac{i_2}{v_2} \right|_{i_1=0}$$



c.) *y*-parameters

d.) *z*-parameters

Consider a voltage amplifier -



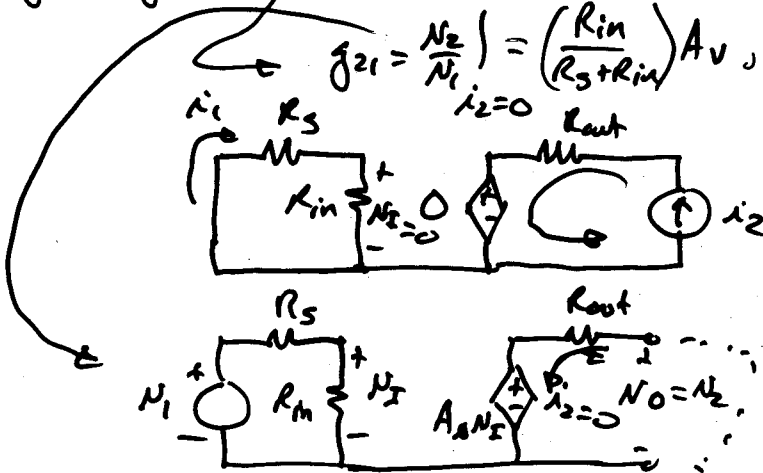
What are the *g*-parameters for this voltage amplifier?

Continued -

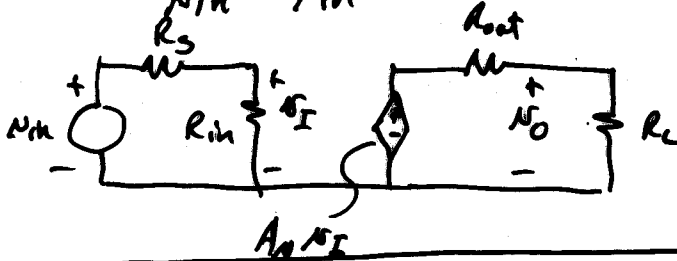
$$i_1 = g_{11} N_1 + g_{12} i_2 \rightarrow g_{11} = \left. \frac{N_1}{N_1} \right|_{i_2=0} = \frac{1}{R_s + R_{in}} \quad g_{12} = \left. \frac{i_1}{i_2} \right|_{N_1=0} = 0$$

$$N_2 = g_{21} N_1 + g_{22} i_2$$

$$g_{21} = \left. \frac{N_2}{N_1} \right|_{i_2=0} = \left(\frac{R_{in}}{R_s + R_{in}} \right) A_v \quad g_{22} = \left. \frac{N_2}{i_2} \right|_{N_1=0} = R_{out}$$



Consider $\frac{N_{out}}{N_{in}} = \frac{N_o}{N_{in}}$ (note: R_L is now attached)



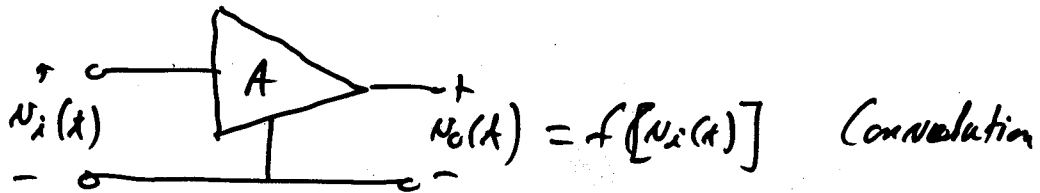
$$\frac{N_o}{N_{in}} = \left(\frac{N_o}{N_I} \right) \left(\frac{N_I}{N_{in}} \right) = \left(\frac{A_v R_L}{R_{out} + R_L} \right) \left(\frac{R_{in}}{R_s + R_{in}} \right) = g_{21} \text{ (if } R_L = \infty \text{)}$$

Other types of amplifiers

	Current	Transconductance	and Transresistance	Voltage
Input	Current	Voltage	Current	Voltage
Output	Current	Current	Voltage	Voltage

FREQUENCY RESPONSE OF AMPLIFIER

Time domain -



Frequency domain -

