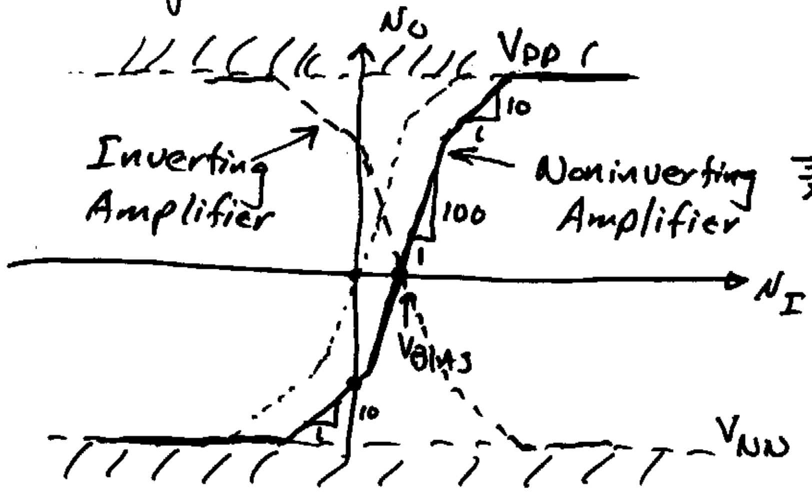
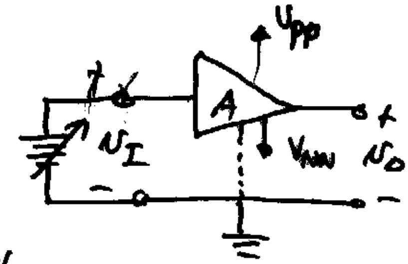
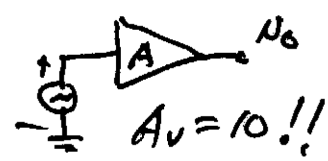
Quiz No. 1 - Friday 8/30 Open book for this quiz.

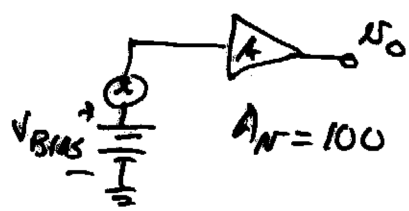
Amplifiers

1.) Voltage transfer characteristic



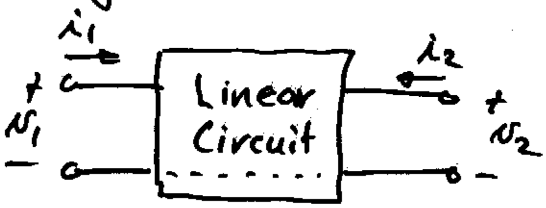






2.) Two-Port Models for Linear Amplifier

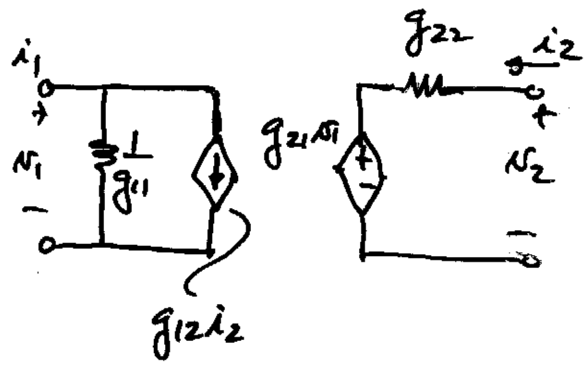
a.) g-parameters



$$i_1 = g_{11} v_1 + g_{12} i_2$$
$$v_2 = g_{21} v_1 + g_{22} i_2$$

$$g_{11} = \frac{i_1}{v_1}\Big|_{i_2=0} \qquad g_{12} = \frac{i_1}{i_2}\Big|_{v_1=0}$$

$$g_{21} = \frac{v_2}{v_1}\Big|_{i_2=0} \qquad g_{22} = \frac{v_2}{i_2}\Big|_{v_1=0}$$



b.) h-parameters

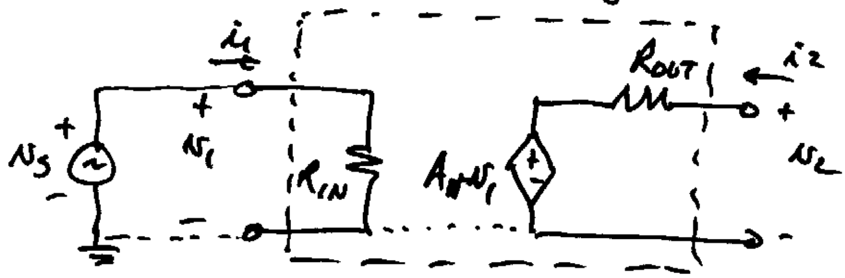
c.) y-parameters

d.) z-parameters

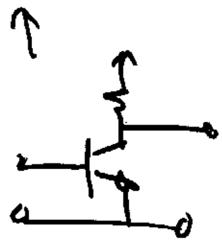
3.) Two-port representation of amplifiers

Basically, an amplifier is a two-port network where the 12 parameter ≈ 0.

a.) An unloaded voltage amplifier – ($R_S = 0$, $R_L = \infty$)



$$i_1 = g_{11} v_1 + g_{12} i_2$$
$$v_2 = g_{21} v_1 + g_{22} i_2$$

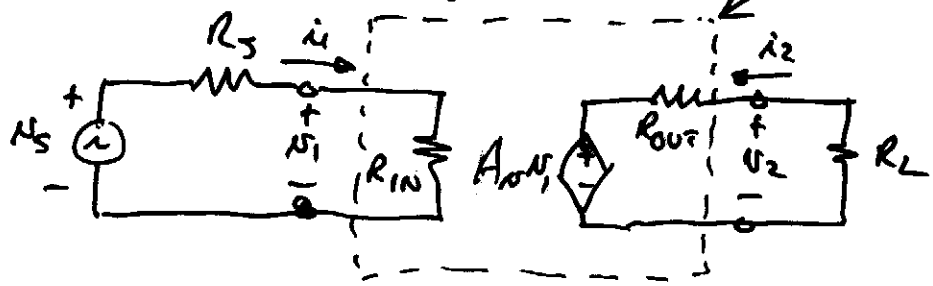


$$g_{11} = \left.\frac{i_1}{v_1}\right|_{i_2=0} = \frac{1}{R_{IN}}$$

$$g_{21} = \left.\frac{v_2}{v_1}\right|_{i_2=0} = A_v$$

$$g_{22} = \left.\frac{v_2}{i_2}\right|_{v_1=0} = R_{OUT}$$

b.) Loaded Voltage Amplifier



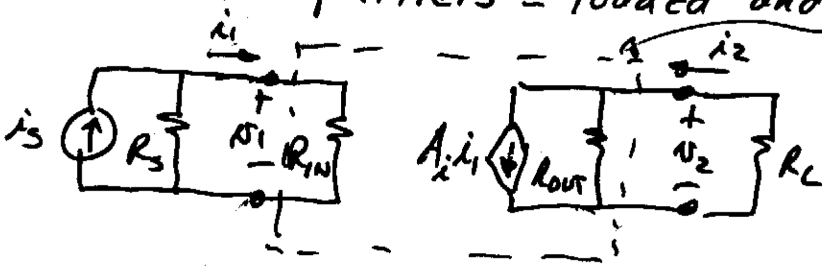
$$A_V = \frac{v_2}{v_S} = \left(\frac{v_2}{v_1}\right)\left(\frac{v_1}{v_S}\right) = \left(\frac{A_v R_L}{R_L + R_{OUT}}\right)\left(\frac{R_{IN}}{R_{IN} + R_S}\right)$$

$$A_V = \frac{A_v R_{IN} R_L}{(R_{IN} + R_S)(R_L + R_{OUT})}$$

$A_V \to A_v$ if $R_{IN} >> R_S$ and $R_L >> R_{OUT}$

4.) Current amplifiers – loaded and unloaded

h-parameter

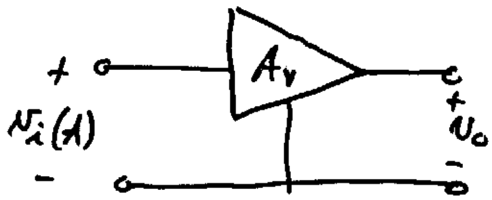


$R_i << R_{OUT}$

$R_{IN} << R_S$

5) Amplifier transfer functions

Time domain –

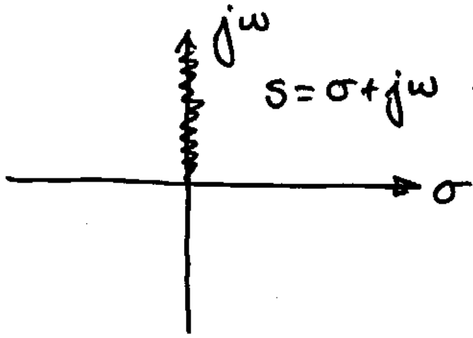


Convolution ↓

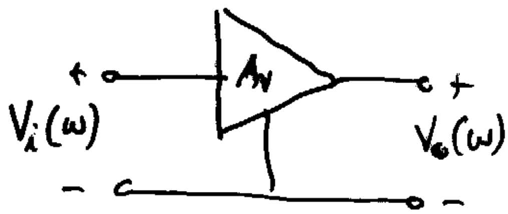
$$v_o(t) = v_i(t) * a_v(t) = \int_0^t v_i(t-\tau)\,a_v(\tau)\,d\tau$$

$a_v(t)$ = impulse response of the voltage amplifier

Frequency domain –



$s = \sigma + j\omega \longrightarrow s = j\omega$



$$A_v(\omega) = A_v(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = \frac{V_o(\omega)}{V_i(\omega)}$$

$$V_o(j\omega) = A_v(j\omega)V_i(j\omega)$$

6) General frequency domain transfer function

$$A_v(s) = \frac{N(s)}{D(s)} = \frac{a_m s^m + \cdots + a_1 s + a_0}{b_n s^n + \cdots + b_1 s + b_0} \qquad m \le n$$

$$= K\,\frac{(s+z_1)(s+z_2)\cdots(s+z_m)}{(s+p_1)(s+p_2)\cdots(s+p_n)}$$

Zeros = Values of s where $A_v(s) = 0 \rightarrow -z_1, -z_2, \cdots -z_m$

Poles = " " " " $A_v(s) = \infty \rightarrow -p_1, -p_2, \cdots -p_n$

Example 1

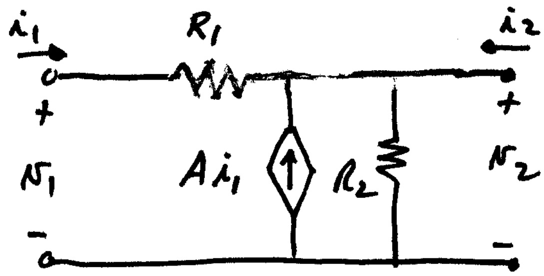
Suppose $A_v(s) = \dfrac{100(s^2+s)}{s^2+110s+1000} = \dfrac{100\,s(s+1)}{(s+10)(s+100)}$

$z_1 = 0$, $z_2 = -1$ rads/sec

$p_1 = -10$, $p_2 = -100$

An Example not done in class.

Prob. 11.17 of text.

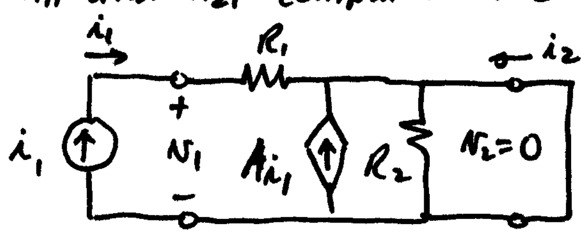


Find the h-parameters

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

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

h_{11} and h_{21} (output short-circuited):

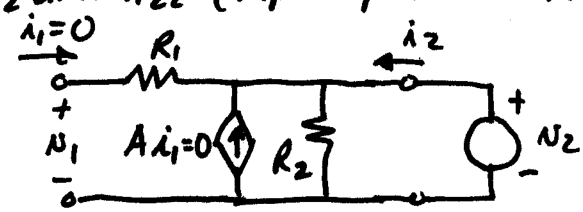


$v_1 = R_1 i_1 + 0 \rightarrow h_{11} = \frac{v_1}{i_1} = R_1$

or $h_{11} = 10\,k\Omega$

$i_2 = -(i_1 + Ai_1) = -i_1(1+A) \rightarrow h_{21} = -(1+A) = -101\ A/A$

h_{12} and h_{22} (input open-circuited):



$v_1 = v_2 \rightarrow h_{12} = 1\ V/V$

$\frac{i_2}{v_2} = \frac{1}{R_2} \rightarrow h_{22} = \frac{1}{240\,k\Omega}$