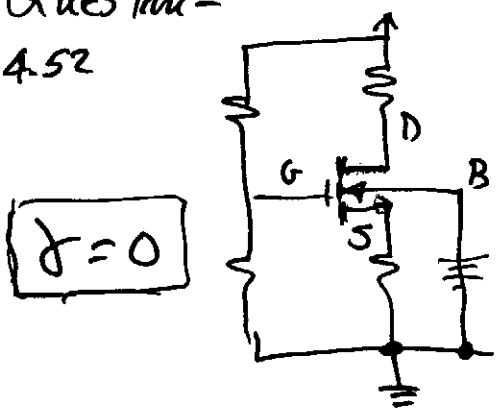
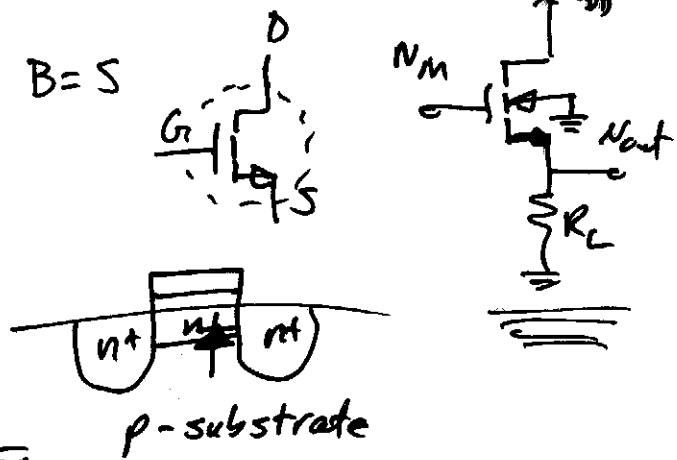
## New office hours

MW - 10-10:55am, 2-2:55pm - Dr. Phil Allen, Room E292-B

TTh - 1-2:55pm - Richard Tarbell (ECE3050 TA), Room E292

Question - P 4.52



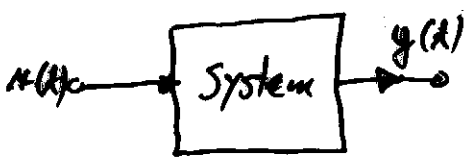




$$V_{TN} = V_{TO} + \gamma\sqrt{2\phi_F - V_{BS}} - \gamma\sqrt{2\phi_F}$$

?

## Chapter 11 - Amplifiers and Frequency Response

### 1.) Linearity




A system is linear iff

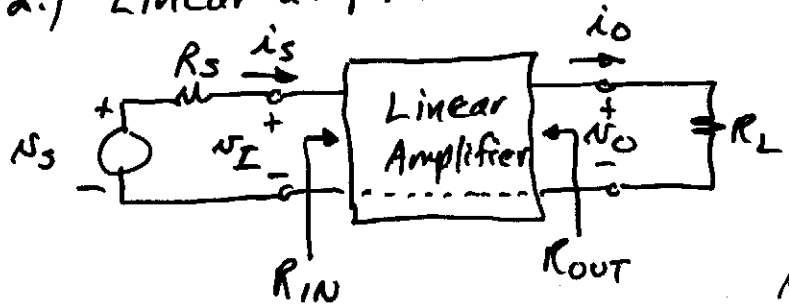
$x_1(t) \longrightarrow y_1(t)$

$x_2(t) \longrightarrow y_2(t)$

$x_1(t) + x_2(t) \longrightarrow y_1(t) + y_2(t)$.

A system is linear if the relationship between $y(t)$ and $x(t)$ is constant for all values of $x(t)$.

### 2.) Linear amplifier




a.) Voltage gain:

$$A_N = \frac{N_O}{N_I} \quad \text{or} \quad A_V = \frac{N_O}{N_S}$$

$$N_I = \frac{R_{IN}}{R_S + R_{IN}} N_S$$

$$A_V = \frac{R_{in}}{R_S + R_{IN}} A_N$$

2.) Cont'd

b.) Current gain $A_I = \frac{i_o}{i_s} = \frac{v_o/R_L}{v_s/R_{IN}+R_s} = \frac{R_{IN}+R_s}{R_L}\frac{v_o}{v_s}$

$A_I = \frac{R_{IN}+R_s}{R_L} A_V$

If $R_s = 0$ & If $R_{IN} = R_L$, then $A_I = A_V$

c.) Power gain

$A_p = \frac{v_o i_o}{v_s i_s} = A_V A_I$

3.) Decibels

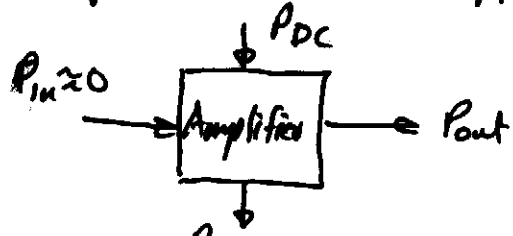
$A_p\ dB \equiv 10 \log_{10}(A_p)$

Assume that $A_V^2 \propto A_p \rightarrow A_V\ dB = 10 \log_{10}(A_V^2)$

$A_V\ dB = 20 \log_{10}(A_V)$

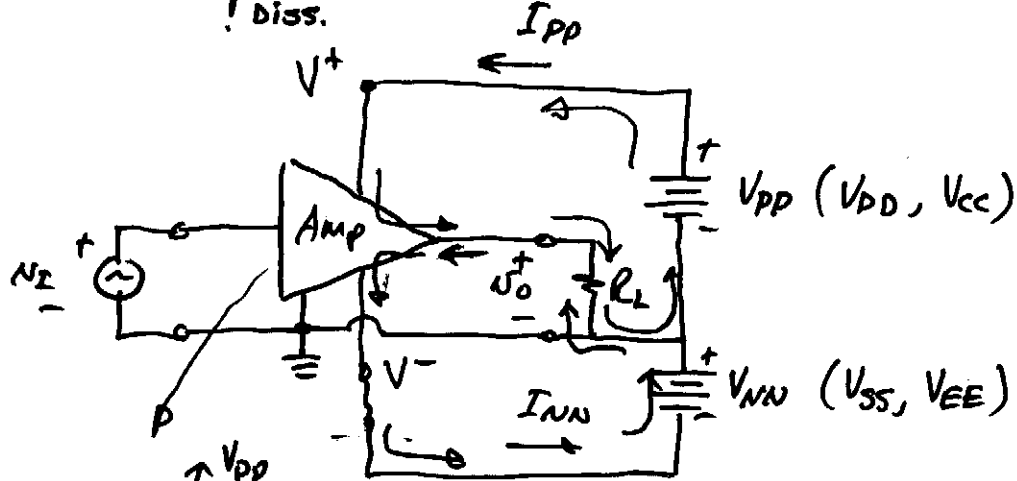
Ratio of same units

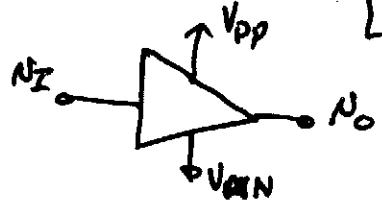
4.) Amplifier Power Supplies



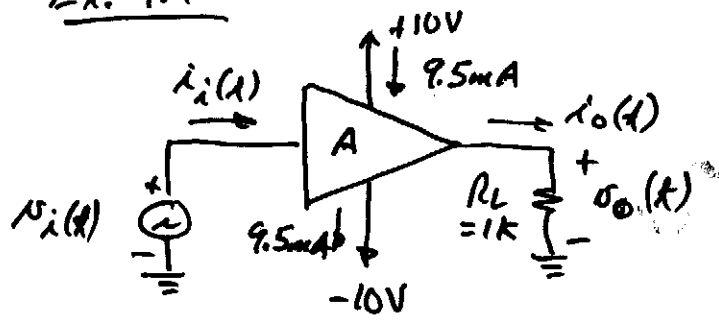

$P_{DC} + \cancel{P_{in}}^{0} = P_{out} + P_{diss}$

$\text{Efficiency} = \frac{P_{out}}{P_{DC}}$



Ex. 4.1




If $v_i(t) = 1 \sin \omega_0 t$,
then $v_o(t) = 9 \sin \omega_0 t$
and $i_i(t) = 0.0001 \sin \omega_0 t$.
Find the efficiency.

$$A_v = \frac{9V}{1V} = 9\ V/V \longrightarrow A_v(dB) = 20 \log_{10} 9 = 19.1\,dB$$

$$i_o(peak) = \frac{v_o(peak)}{R_L} = 9\,mA \longrightarrow i_o(t) = 9\,mA \sin \omega_0 t$$

$$A_i = \frac{9\,mA}{0.1\,mA} = 90\ A/A \longrightarrow A_i(dB) = 20 \log_{10}(90) = 39.1\,dB$$

$$P_L = (9V/\sqrt{2})\left(\frac{9\,mA}{\sqrt{2}}\right) = \frac{81\,mW}{\sqrt{2}\sqrt{2}} = 40.5\,mW$$

$$P_I = \left(\frac{1V}{\sqrt{2}}\right)\left(\frac{0.1\,mA}{\sqrt{2}}\right) = \frac{0.1\,mW}{2} = 0.05\,mW$$

$$A_p = \frac{40.5}{0.05} = 810\ W/W$$

$$A_p(dB) = 10 \log_{10}(810) = 29.1\,dB$$

$$P_{DC} = 10V(9.5mA) + 10V(9.5mA) = 190\,mW$$

$$P_{diss} = P_{DC} + P_I - P_L = 190 + 0.05 - 40.5 = 149.65\,mW$$

$$\eta = \frac{P_L}{P_{DC}} = \frac{40.5\,mW}{190\,mW} \times 100\% = \underline{\underline{21.3\%}}$$