Operational Amplifiers Practice Work Handout 1
Assume +/-15VDC supplies and $A_{ol}=200,000$.

1. Perform the conversions below.
   
   $A_v = 40$  \hspace{1cm} $A'_v = \phantom{0} \text{dB}$
   
   $A'_v = -18 \text{ dB}$ \hspace{.5cm} $A_v = \phantom{0}$
   
   $P = .125 \text{ Watts}$ \hspace{.5cm} $P'$ = \phantom{0} \text{dBW}$
   
   $V' = -12 \text{ dBV}$ \hspace{.5cm} $V = \phantom{0} \text{Volts}$

2. For the circuit below, sketch the output waveforms given inputs of +3VDC, 0VDC, and -5VDC.

   ![Circuit Diagram]

3. Find the voltage gain, input impedance, and output voltage. If $f_{\text{unity}}$ is 2 MHz, find $f_2$.

   ![Circuit Diagram]

4. For the circuit below, find the voltage gain, input impedance, and output voltage. If slew rate is 2 volts per microsecond, find $f_{\text{max}}$ (power bandwidth) for a 10 volt peak output.

   ![Circuit Diagram]
1. Perform the conversions below.
\[ A_v' = 20 \cdot \log_{10} A_v = 32 \text{ dB} \] (note this is 2*2*10, or 6dB+6dB+20dB)
\[ A_v = 10^{(A_v'/20)} = 0.125 \] (the equation above, “backwards”)
\[ P' = 10 \cdot \log_{10} (P/P_{ref}) \] (where dBW uses 1 W ref) = -9 dBW
(or, 0.5*0.5*0.5 which is -3dB-3dB-3dB)
\[ V = V_{ref} \cdot 10^{(V'/20)} \] (where ref = 1 Volt) = 0.25 Volts
(or, -6dB-6dB, which is 0.5*0.5 = 0.25)

2. Sketch the output waveforms given inputs of +3VDC, 0VDC, and -5VDC.
The reference is -2V so anything larger than this produces positive saturation (about +13 to +14VDC, for inputs one and two) while anything less than -2V produces negative saturation (about -13 to -14VDC, for input three).

3. Find the voltage gain, input impedance, and output voltage. If \( f_{\text{unity}} \) is 2 MHz, find \( f_2 \).

\( Z_{\text{in}} \) is set by the 33k.
\[ A_v = 1 + R_f/R_i = 1 + 10k/2k = 6. \]
\[ f_2 = f_{\text{unity}}/A_{\text{noise}} = 2\text{MHz}/6 = 333\text{kHz}. \] (note \( A_n = A_v \) for this amplifier)

4. Find the voltage gain, input impedance, and output voltage. If slew rate is 2 volts per microsecond, find \( f_{\text{max}} \) (power bandwidth) for a 10 volt peak output.

\( Z_{\text{in}} \) is set by \( R_i = 10k \).
\[ A_v = -R_f/R_i = -80k/10k = -8. \]
\[ V_{\text{out}} = V_{\text{in}} \cdot A_v = 0.1V \cdot (-8) = 0.8 \text{ volts inverted}. \]
\[ f_{\text{max}} = \frac{SR}{(2\pi V_{\text{peak}})} = \frac{2E6}{(2\pi \times 10V)} = 31.8 \text{ kHz} \]
(note 2 V/uSec = 2E6 V/Sec)