Name: _____

# MUS 348 / EE 480

**Spring 2010**
**EE Problem Set #1**

For professional audio equipment, both the input and the output impedance are typically 600 Ω. The standard nominal signal level is stated to be +4 dBm into 600 Ω. This means that when a 600 Ω load is attached to the amp's output, a nominal signal will cause the power dissipated in the 600 Ω load resistor to be +4 dB with respect to 1 mW.

(a) With the 600 Ω load attached and a sinusoidal signal at a +4 dBm level, what is the RMS voltage across the load? What is the peak-to-peak voltage across the load? What is the Thévenin equivalent voltage for the amp?

(b) When short interconnections and minimal noise is expected (like in consumer stereo systems), audio gear can be designed with a low output impedance ($Z_{out} \approx 100\ \Omega$) and a high input impedance ($Z_{in} > 10\ k\Omega$) to maximize *voltage* transfer rather than a matched impedance to maximize *power* transfer.

If we replace the 600 Ω load by hooking the pro amp's output to the high-impedance input of a consumer digital audio recorder, $Z_{in} = 10\ k\Omega$, what is the peak-to-peak voltage at the load, assuming the amp's Thévenin voltage did not change?

(c) In systems designed for voltage transfer rather than power transfer, it is customary to describe signal levels in terms of dBV (dB with respect to 1 volt) instead of dBm. In the case of part (b), i.e., amp with 600 Ω output impedance driving a 10 kΩ input, express the signal level at the load in dBV.

A few reminders:

dB is the decibel. The *bel* is defined to be the base ten logarithm of a power ratio.

$$bel = B = \log_{10}\left\{\frac{Power_1}{Power_{ref}}\right\}$$

For a variety of reasons, it is customary to use a unit that is one tenth of a bel, the *decibel*.

$$dB = 10 \cdot \log_{10}\left\{\frac{Power_1}{Power_{ref}}\right\}$$

If the reference $Power_{ref}$ is defined to be 1 mW, the level is indicated as dBm.

The power dissipated in a resistance $R$ ohms can be expressed as $V^2/R$, where $V$ is the RMS voltage across the resistor. If we compare two power levels specified with the *same* resistance R, we can express the dB ratio as

$$10 \log_{10}((V_2^2/R)/(V_1^2/R)) = 10 \log_{10}((V_2/V_1)^2) = 20 \log_{10}(V_2/V_1)$$

The 20 multiplier appears because the dB must be a ratio of two power values.

If the comparison voltage $V_1$ is defined to be 1 volt, the level is indicated as dBV.

The *output impedance* of a source is the Thévenin equivalent impedance viewed at the output.

The *input impedance* of a circuit represents the loading (V/I) of this circuit.