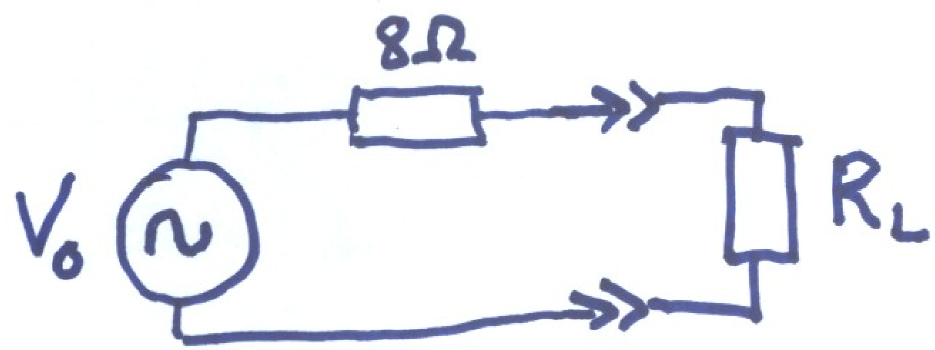
Homework #8 (Chapter 7)

Recall from lecture that Ohm's law (V=I*R) describes current flow in circuits where V is the electrical force (Voltage in "Volts"), I is the electrical motion (current in "Amps") and R is the electrical impedance (Resistance in "Ohms"). If two resistances R_1 and R_2 are connected in series then the total resistance is equal to $R= R_1 + R_2$. Power is the product of voltage and current P=I*V.

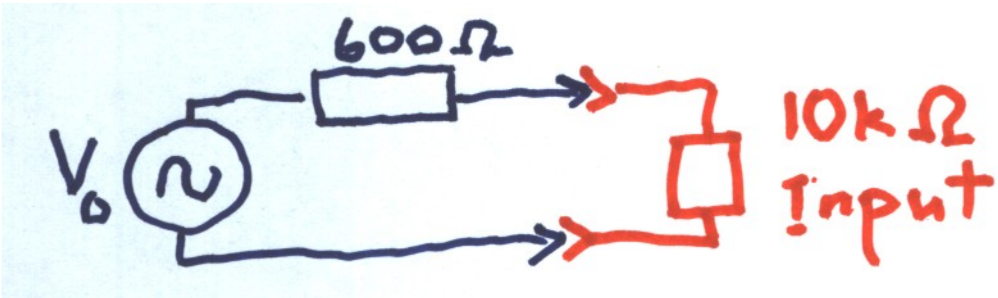
Devices such as microphones, amplifiers, and speakers can be represented by their electrical equivalent (combination of voltage sources and impedances) in order to understand them. For example, a microphone can be thought of as a voltage source in series with a resistance (this is also the case for an amplifier *output*). An amplifier *input* can be thought of as a simple resistance. Below is a simple schematic drawing that could represent a microphone being connected to an amplifier, *or* it could represent the output of an amplifier (with equivalent voltage V_0 and impedance 8 Ohms – often written as 8Ω) - being connected to a speaker (with impedance R_L). Let's consider the second case first.



Question 1

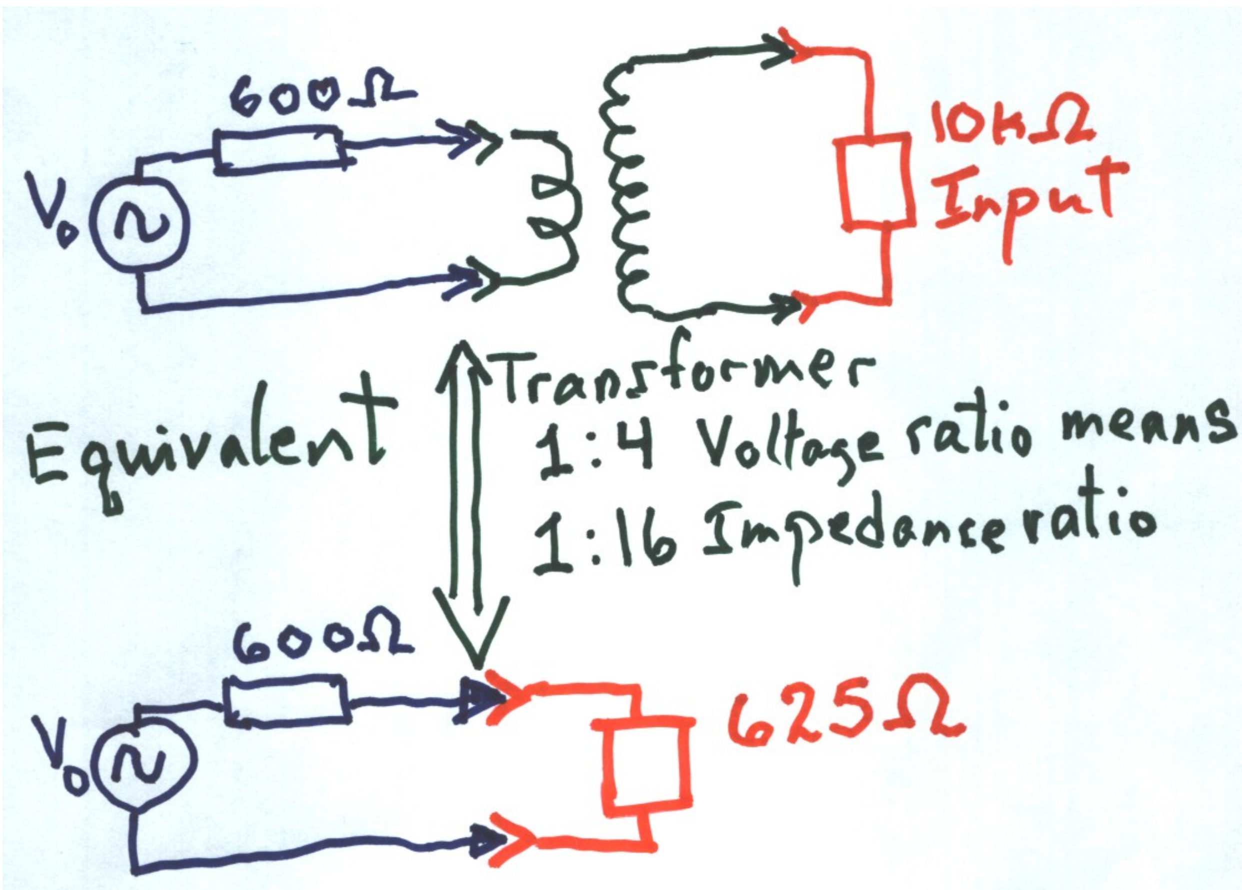
A) Consider an amplifier with internal voltage of V_0=24V and internal impedance of 8 Ohms. Find the current in the circuit if the speaker impedance (R_L)=4Ω. What about when it is 8Ω?
B) For each of the two cases, what is the voltage across R_L? (hint, use Ohm's law).
C) For each of the two cases find the power delivered to R_L.

A transformer is analogous to a mechanical lever – you can use it to "jack up the voltage" or to reduce it. It does not do work for you, it allows you to change how you do work so that you are more efficient at delivering power. A transformer may be necessary for a dynamic microphone (a relatively "low impedance" microphone with an impedance often around 600Ω) if you want to connect it to an amplifier with a high impedance input (say 10,000Ω as in the drawing below). Take V_0=24mV=.024V.



Question 2

A) Find the total power delivered to the amplifier input (this is just like what you did for question 1C).



B) Inserting the transformer now makes the amplifier input appear to be easier to move – to use the mechanical analogy. If its impedance is transformed to 625Ω, how much power is now delivered to the amplifier input?

Question 3

A) Convert the numbers 2, 15, 33, and 127 into binary.
B) Convert 0011, 1000, 1010, and 1110 to base 10.

Question 4

A) For 16 bit sound, one bit is used to tell the sign (whether it is a positive or negative number) and the remaining 15 bits are used to encode the amplitude in binary. If the smallest non-zero amplitude is represented by 1, then the largest amplitude that you can record is 2^{15}-1=32767. Power is proportional to the amplitude squared. What is the dynamic range (in dB) of 16 bit sound?
B) The human hearing system can handle a dynamic range of typically 120 dB. Approximately how many binary bits would it take to have this dynamic range?