Show all work! Start with the BASIC equations! Explain completely! Answer each question on a separate sheet of paper.

1. For the circuit shown, calculate:
   a) The total impedance seen by the power supply (as a complex number and as a magnitude)
   b) The RMS current in the circuit
   c) The gain of the circuit

![Circuit Diagram]

2. a) In the following circuit, the load resistor (a sensitive piece of electrical equipment – an Xbox), needs a voltage of 52 $V_{\text{rms}}$, while the power supplies 120 $V_{\text{rms}}$ at a frequency of 60 Hz. If the power supply has an internal impedance of 800 $\Omega$ (as shown by the resistor in series with the ideal power supply), what resistance must the resistor have to maximize the power transferred to the load?
   b) What power will be dissipated in the load resistor at that resistance?

![Circuit Diagram]
3. a) Explain the physical principles behind how a normal diode works. What does a diode do in a circuit?

b) For the following circuit, if the input signal is a 20 volt (peak-to-peak) sine wave, draw the output voltage. Each diode has a zener voltage as shown. Justify your answer.

4. a) Explain how a photoresistor can be used to measure the intensity of a light source.

b) Draw a simple circuit which would use a resistive transducer to measure the intensity. Explain how the circuit works, and what you actually measure in the circuit.

c) Bonus: Derive an expression for $R_T$ (the transducer resistance) in terms of other fixed quantities in the circuit and things measured in the circuit.

**Bonus:** Calculate the total impedance of the circuit if it is run at 10000 Hz.