Lab 5: Diodes

(estimated time: 30 minutes)
1. Measure the I-V characteristic of a diode (you may use a regular diode or an LED). Please make sure that you do not exceed ~100 mA though the diode. A good way to measure the I-V curve is to use the "one-way current gate" circuit from the course notes so that the resistor limits the current flowing through the circuit.

(estimated time: 30 minutes)
2. Construct the full-wave rectifier with a voltage signal at 10 kHz, 4 diodes, an audio transformer, and a load resistor of 100 kΩ. Measure the amplitude of the input signal and characterize the output signal through the load resistor. Why do we need the transformer?

(estimated time: 30 minutes)
3. (same set-up as question 2) Use the FFT (Fast Fourier Transform) function to measure the frequency spectrum of the output. Measure the amplitude and frequency of the principal harmonics (i.e. the one you can see). How do you convert dB to Volts? What FFT window did you use? Does it matter?

(estimated time: 1 hour … (infinite, if you are not prepared))
4. Design and construct a frequency doubling circuit which converts 10 kHz to 20 kHz (you don't have to use exactly 10 kHz, but the output frequency should be exactly twice the input frequency). Your design has the added requirement that it must be able to produce the doubled frequency with the other harmonics suppressed by at least -30 dB compared to the doubled frequency, and with an output load resistor of about 100 kΩ (this is doable experimentally – theoretically, you can do much better of course). The output should not include a DC bias. There is no absolute output amplitude requirement for the doubled frequency, though more is always better.
Characterize your circuit (i.e. show that it does what it is suppose to).
Note: several circuit designs are possible.

(estimated time: 15 minutes)
5. (same set-up as question 4) Measure the power conversion efficiency from 10 kHz to 20 kHz.
Qualitative design question: If you wanted to make a frequency quadrupler for conversion of 10 kHz to 40 kHz, would you be better off with two of your doublers (2^{nd} doubler appropriately modified for the new frequency requirements) or a single doubler with a different harmonic suppression scheme (you will need data from question 3 to answer this) – you do not need to make a frequency quadrupler!

(estimated time: 15 minutes)
6. (same set-up as question 4) Measure the output impedance, Z_{TH}, of your frequency doubler (if necessary, in the vicinity of a 100 kΩ load resistor).