Week 1: DC/RC circuits and capacitors

**General guidelines:**
You lab report should include the following:
- Section title using the same labeling as the weekly lab instructions.
- Circuit diagrams (see “How to draw circuit diagram” on the course website, under Links), labeling the elements and their values. Setting used for scope/function generators, voltages (ie sufficient amount of details so that one could reproduce your setup and verify what you did).
- Sketch of additional circuits you used to make a measurement or verify something.
- Output waveform from the oscilloscope (screenshots are fine, but make sure to label them: legend, axis, and caption. Show both input and output waveform.).
- Measurements taken. If appropriate use tables, labeling columns/rows and giving units.
- Sample calculation (using same notation as in your circuit diagrams).
- Your observations/remarks.
- Answers to each question from the lab handouts.

A good practice when you go through the experiments is to first workout what is the expected signal output.

**Lab 1.4 Voltage Divider (p28)**

**Reading:** p3-14 “DC circuits” (skim p15-28).

**Equipment:** Breadboard, DC PS, digital multimeter, banana-banana cables and two alligator clips, three 10k resistors and some wires.

Follow the instructions in the lab manual for lab 1.4 (p28), and answer the following in your report:
1) Draw your two circuits for measuring the Thevenin equivalent voltage and resistance.
2) Give your measured values for the Thevenin equivalents ($V_{Th}$, $R_{Th}$)
3) Show your calculation of the expected Thevenin equivalents.
4) What output voltage do you measure with the 10K load attached to the voltage divider?
5) What output voltage do you measure with the 10K load attached to the Thevenin equivalent circuit you built?
6) What approximation did you make in order to measure the Thevenin equivalents?

**Lab 2.2 to 2.5 Capacitors (p54 to 57)**

Reading: p32-45 “Capacitors and RC circuits” (skim p46-53).

Follow the instructions in the lab manual for:
- Lab 2.2: Differentiator (p55)
- Lab 2.3: Integrator (p55)
- Lab 2.4: Low-pass filter (p56)
- Lab 2.5: High-pass filter (p57)

In lab 2.2, ignore the stuff about setting the function generator attenuator to 20dB etc... We use a different model.

Note that RC in seconds when R is in Ohms and C in Farads.

The “-3dB point” is just a fancy way of saying the frequency where the output voltage: 
\[ V_{\text{out}} = \frac{V_{\text{in}}}{\sqrt{2}} \] 
(ie ~70% of V(in) )

For “impedance”, substitute “resistance” and remember that capacitor's resistance is: 
\[ \frac{1}{2\pi f C} \]

Answer the following in your report:
1) Sketch the input and output waveforms you obtain using square, triangle and sine inputs fed into your differentiator and integrator circuits. Label your axes, including units.
2) Do your output waveforms make sense? Why or why not?
3) Calculate what you expect the (-)3dB points to be for your low-high-pass filters.
4) Describe how you measured the (-)3dB points of the low- and high-pass filters. Show your calculations and results.

**Lab 2.8 Blocking capacitor (p59)**

Follow the instructions in the lab manual for lab 2.8 (p59).

Answer the following in your report:
1) Sketch what happens to a sine wave as it passes from the input to output (A) to output (B).
2) What practical applications might circuits (A) and (B) have?
3) A polarized capacitor must always have one side more positive that the other. What are the requirements on V(in) for this to be true in circuit (A)?