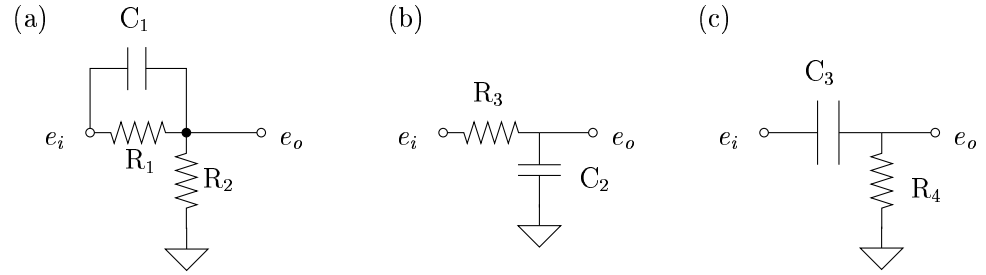

Using the supplied components, construct each of the circuits shown in the figure above on a breadboard. Use the values given in the prelab ($R_1 = 100$ kΩ, $R_2 = 47$ kΩ, $R_3 = R_4 = 10$ kΩ, $C_1 = 0.1$ μF, and $C_2 = C_3 = 0.047$ μF). At each station, you will find a diagram showing the locations of the conductors within a breadboard and a guide to resistor color codes.

1. For each circuit, use the function generator to apply a step in the input voltage e_i and set the oscilloscope to record both the input e_i and output e_o of the circuit. Record the step response and determine the time constant τ. Compare the measured responses with those that you computed in the prelab.

2. The properties of electronics components vary somewhat from their designated values. Using a multimeter, directly measure the resistance R_4 of the resistor that you used in circuit (c). Based on the measured values, compute the value of C_3.

3. Now use the signal generator to apply a sinusoidal signal of frequency f to circuit (c).

   (a) Measure the magnitude and phase of e_o relative to e_i when f is approximately 1, 115, 1000, and 10000 Hz.

   (b) Find the frequency f_c at which the phase difference between e_o and e_i is 45 degrees. What is the magnitude of the response at f_c? How is f_c related to the time constant τ?

   (c) Plot the measured values of magnitude and phase on the frequency response plot that you generated in the prelab. Are your results consistent with the model?

4. If time permits, repeat Problem 3 for circuits (b) and (c).