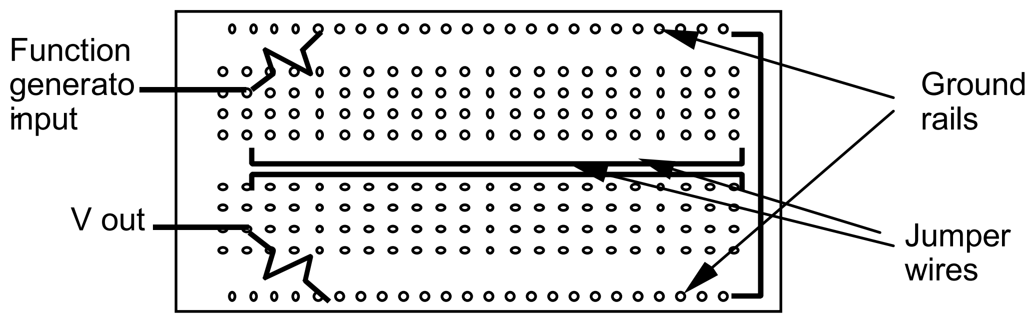
Introduction to Fields and Waves

Reading Assignment
Ulaby, 1-1, 1-2

Experiment 1 - capacitive coupling
Connect the circuit together as shown in the diagram below. Note that the spatial layout of the jumper wires is important in this experiment. Use resistors that are approximately 10 kΩ. Set the function generator to 30 kHz with a 10 V P-P output.



The two dark lines down the center represent parallel wires, forming a capacitor. They are connected to the resistors on the right side of the image. On a protoboard, the rows of five holes form discrete nodes and the columns on the edges and center form discrete nodes.

How large a voltage do you measure at V_{out}? Is it what you expected? Vary the spacing between the wires and the frequency. What changes occur?

Experiment 2 - Transformers, Ground loops
a. Connect the output of the function generator across a 1 μH inductor using a coaxial cable and a coax to clip-leads adapter. Set the function generator frequency to 1 MHz and the amplitude to 10 V P-P. Take a second cable of the same type, wrap the leads around the inductor, connect them together, and then plug the BNC end into the oscilloscope. What do you observe? Vary the frequency and the wire positions.

b. Remove the inductor and its cable, but keep the 2nd cable plugged into the scope. Set the trigger on the scope to LINE and the time scale to 5 ms/division. Leave the cables leads unconnected and observe the signal on the scope. Put the cables near equipment power cords, computer screens, etc. Try looking at other time scales.

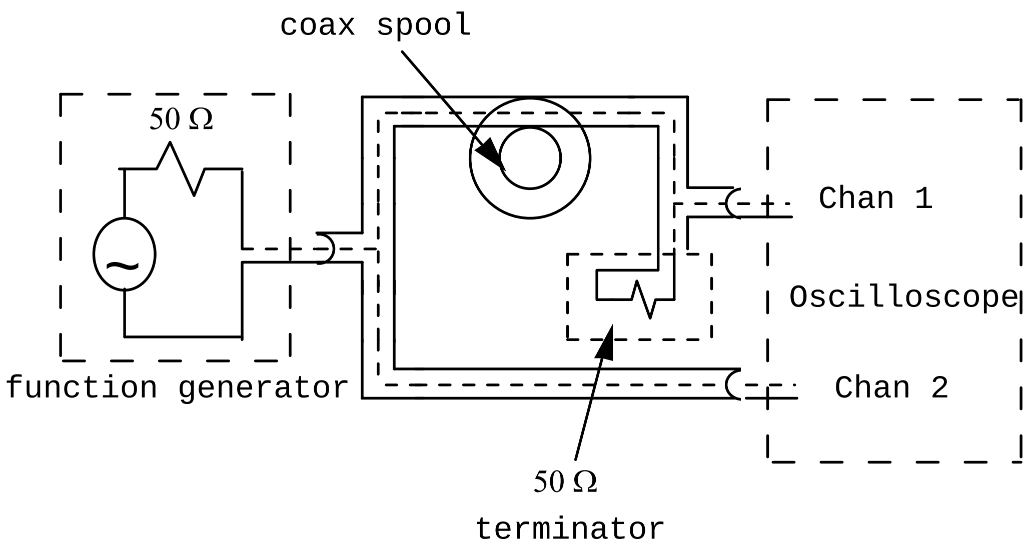
Experiment 3 - Transmission lines

Connect a simple circuit with a long spool (80 ± 20 meters) of coaxial cable as shown below.

a. Obtain a sine wave from the function generator. Set the frequency to 10 kHz. What do you observe?

b. Do the same experiment, but at higher frequencies. Try several between 100 kHz and 1 MHz. What additional effect appears? Can you qualitatively explain what you observe?

c. Remove the 50 Ω termination at the oscilloscope and repeat the experiment.



Experiment 4 - radiation and wave propagation

Create a receiving antenna using a simple wire connected to the oscilloscope through a coaxial cable with coax to clip-lead adapter. The receiving antenna is the same as the transmitting antenna which will be set up in the room. The transmitting antenna will be operated at 13.56 MHz (One approved by the FCC for general use).

Set the oscilloscope time scale to about 50 ns/div. (Autoscale will probably not be very useful here). What do you observe?

This experiment can be used to model radiation at 400 MHz if you multiply all distances by 13.56/400. Is radiation an important consideration for computer chips?

Alternate Experiment 2 - Motion sensor
Connect a strain gauge to the oscilloscope. Monitor the voltage across the coil as the lever arm vibrates.