Fields and Waves I
Studio Session 2
Spring 2024
Due 11:59pm, Jan 31st

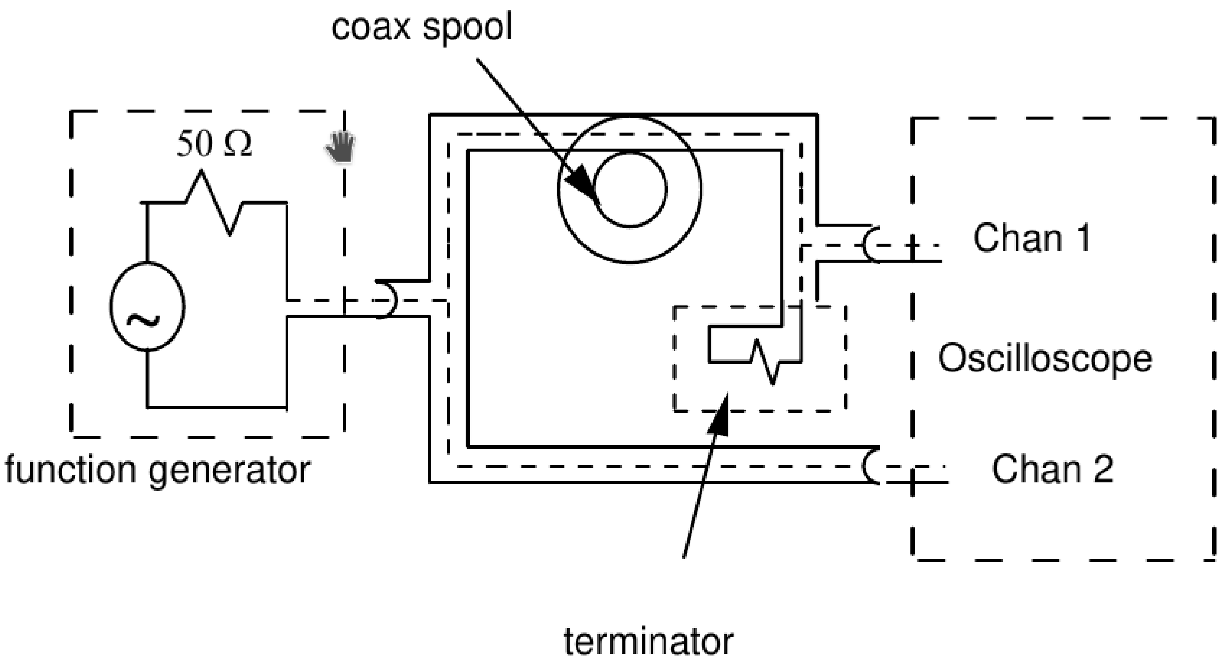
When you have completed the lab, submit the answers to the underlined questions on Gradescope. If you wish, you may work with a partner and submit one report for both of you. There is no need for a “formal” lab report.

Question 1: Obtain a long spool of coaxial cable. Based on what’s printed on the insulation, look up the cable parameters online. What is the cable’s characteristic impedance? Now look at the input impedance of the oscilloscope at your station. What is it? Based on what these two impedances are, predict what will happen when you plug the long cable into the oscilloscope. Will a signal on the cable reflect as it hits the oscilloscope input? Assume that the cable is lossless.

Question 2: Now plug one end of the long cable into the function generator at your station and the other end into the oscilloscope. Output a sinusoidal signal from the function generator – something between 1kHz and 100kHz. Is the amplitude you measure at the oscilloscope the same as the amplitude you are outputting from the function generator? Why or why not? **Include a picture of the oscilloscope screen in your report submission.**

Question 3: Connect a splitter to the input port of the oscilloscope. Attach the coax cable to one end of the splitter and output the same signal you used for Question 3. Attach a terminating resistor, as shown in the picture above, to the other end of the splitter. Does the amplitude you measure at the oscilloscope change? If so, are you observing reflection? If you are observing reflection, estimate the reflection coefficient. **Include a picture of the oscilloscope screen in your report submission.**

Question 4: Based on the reflection coefficient you calculated, what is the effective load impedance of the oscilloscope plus the terminating resistor? What is the resistance of just the terminating resistor? (Keep in mind that the oscilloscope and the terminating resistor are effectively two resistors in parallel.)



Question 5: Connect a simple circuit with a long spool of coaxial cable as shown above Use a short cable to connect the function generator to Channel 2. The picture above shows a terminating resistor in parallel with Channel 1. **This is optional – use it if you determined in the previous steps that it reduced or eliminated reflection, but omit it otherwise.**

Question 6: Input a sinusoidal frequency of at least 100kHz. Can you see evidence of the long coaxial spool's time delay? If so, what do you estimate that the time delay is? **Justify your answer with a screenshot.**

Question 7: Look up the signal velocity of the cable you are using. This will often be reported as a "velocity factor" – that is, a fraction of the speed of light. Based on the time delay and the velocity factor, how long is your spool of cable?

Question 8: Do you observe any evidence of losses on the coaxial spool between the input and output? If so, **justify your answer with a screenshot.**

Question 9: Now increase the frequency to something above 1 MHz. Do you observe evidence of losses now? If so, is the degree of loss different from what you saw in Question 8? **Justify your answer with a screenshot.**

Question 10: Replace the coaxial spool with a lumped line box. What is the time delay now? What length of coaxial cable would have an equivalent time delay to your lumped line box? **Show a screenshot of the box's time delay as shown on the oscilloscope.** What length of transmission line does each stage (i.e. inductor-capacitor pair) of the box represent?