Purpose

The purpose of this experiment is, for an LR circuit, (1) to find the equation relating the voltage across the inductor to time, (2) to find the relationship between the time constant of the circuit and the resistance in the circuit and (3) to determine the inductance of the inductor in the circuit.

Procedure

Use the coaxial cables to connect the circuit shown in Figure 8.2.

1) Connect the output of the function generator to the LR circuit apparatus.

2) Connect the LR circuit apparatus to the CH 1 input of the oscilloscope.

3) Connect the TTL/CMOS output on the function generator to the EXT TRIG input of the oscilloscope.

Set the resistor select switch on the LR circuit apparatus to position 1.

Function Generator Settings: Set the frequency for 600 Hz with the Output Level set to maximum. All other button settings on the function generator should be OUT.

The square wave generated by the function generator has the effect of opening and closing a switch (like the one in Figure 8.1) at the rate of 600 times per second.

Preliminary Oscilloscope Settings:

1. Press the CH 1 menu key, then select Coupling DC, Channel ON, Probe 1X, Inverted OFF.

2. Press the TRIG menu key, then select Type Edge, Slope Rising, Source EXT, Mode AUTO, and Coupling DC.

3. Set the VOLTS/DIV for CH 1 to 100 mV/cm, the SEC/DIV to 500 µs/cm, and then adjust the trig level to 200 mV.

You should get a signal like the one shown in Figure 8.3, which displays the voltage across the inductor as a function of time. The square wave signal from the function generator shows the decay curve at the trailing and leading edges of each pulse.
Now set the VOLTS/DIV to 10 mV/cm and the SEC/DIV to 100 µs/cm and adjust the position of the trace so that the baseline rests at the bottom of the display as shown in Figure 8.3. The signal traces a curve which is the graphical representation of Equation (8.3).

**Determination of Equation (8.3):** Expand the horizontal scale to 10 µs/cm with the SEC/DIV knob so that the decay curve fills the screen as shown in Figure 8.4. Use the horizontal POSITION knob to move the trace so that it starts in the upper left portion of the display.

Press RUN/STOP to freeze the display, then press the CURSOR key and select Type Voltage. Adjust CURSOR 2 so that it rests at the bottom of the display, which corresponds to the baseline of the decay curve.

Use CURSOR 1 to read the voltage at each point where the curve crosses a vertical (time) grid line. Assign time \( t = 0 \) to the left-hand edge of the display; subsequent readings will be at \( t = 10 \) µs, 20 µs, etc. Since CURSOR 2 has been set at the base of the curve, \( V_0 = 80 \) mV, and the subsequent voltage readings are displayed on the right hand side of the screen under Delta in the cursor menu.

Plot a graph of \( \ln V \) versus \( t \) on semi-log paper. Find the time constant \( \tau \) of the circuit from the slope of the graph. (It's just the reciprocal of the absolute value of the slope.) Use the values for the intercept and the time constant to write the equation that applies specifically to your circuit in the same form as Equation (8.3).

**Determination of Equation (8.4):** For each of the dial settings from 1 to 10 on the L R circuit apparatus, find the time \( t_{1/2} \) required for the voltage across the inductor to be reduced by half.

Expand the horizontal scale with the SEC/DIV knob on the oscilloscope to so that the time required for the voltage to fall to half its original value takes up at least half of the distance on the screen (i.e., at least five scale divisions). Use the horizontal POSITION knob to move the trace so that you can see the top of the square wave in the upper left portion of the display, as shown in Figure 8.5.