Recall that the RL Circuits lab starts on page 229 of your lab manual. Read the introduction to acquaint yourself with the theory relating to RL circuits (pages 229-230, bottom of 234-238, 241). Recall that we used the Pasco interface box to take data in the RC Circuits lab. For the RL Circuits lab, we are going to use a function generator and oscilloscope so the procedure will be slightly different than what is in the lab manual.

The RL circuit board is the same as used in the lab manual. In the Excel worksheet shown in Fig.6 on page 246 of your lab manual, calculate the time constant $T$, $20T$, and signal frequency $f$ for an 8.2 mH inductor and 100 $\Omega$ resistor. Set the function generator to output the signal frequency that you calculated in your Excel worksheet and set the output waveform to a square wave as shown in Fig.1. Next complete the circuit as shown here in Figs. 2 and 3.
Figure 1. A function generator outputs a square wave at a frequency of 609.8 Hz.

Figure 2. The function generator connects to points Q (red lead) and C (black lead) on the RL circuit board. Points P (red lead) and C (black lead) are connected to an oscilloscope to measure the voltage drop across the 100 Ω resistor.

Figure 3. The function generator connects to points Q (red lead) and C (black lead) on the RL
circuit board. Points P (red lead) and C (black lead) are connected to an oscilloscope to measure the voltage drop across the 100 Ω resistor.

**Set the oscilloscope up so that you can see the voltage drop across the resistor.** The waveform should look like that shown in Figs. 4 and 5. The waveform is offset so that it can be seen on the screen. You can see the yellow arrow with a 1 on it on the left of the screen. The yellow arrow shows the offset value and is normally set at the zero line. Therefore, the voltage signal is all positive above the zero line when you remove the offset. Compare this waveform to the one in Fig. 4 on page 241 of your lab manual.

Figure 4. The voltage signal across the 100 Ω resistor in the RL circuit. Notice the little yellow arrow with the 1 on the left of the screen in the picture. That marks the offset of the signal. If there is no offset, then that yellow arrow with the 1 would be in the middle of the screen on the zero line. So this means that all of the signal is positive.
You will want to zoom in as much as possible on the signal on the oscilloscope and capture the decay of the signal. If your signal takes up less of the screen of the oscilloscope, then the resolution of the data will not be very good since the data is binned (less bins for the same data give less resolution). Collect the data using the Tektronix OpenChoice software located on the desktop. (The data will be all positive – the offset just helps visually see the data on the screen of the oscilloscope better.)

To collect the data, make sure that the USB connection is highlighted under “Select Instrument” under the “Screen Capture” tab. Click on the “Waveform Data Capture” tab and select Channel 1. Under the “Screen Capture” tab, select “Get Data” and then “Save As” and save the data as a .csv file. Open the data in Excel.

Now you will need to analyze the data. Copy the data from Excel and paste it into a table in the Pasco Capstone software. Graph the data. Now use the highlighting tool in the Pasco Capstone software to select the decay of the signal. Then use the exponential fitting tool to fit the data and determine the time constant. Is this value close to the value that you expected? How would the tolerance in the resistor and inductor values affect your time constant?
The voltage drop across the inductor is measured with the oscilloscope by connecting the red lead to point P and the black lead to point Q as seen in Fig. 6. An example waveform is shown in Fig. 7. The voltage source is measured with the oscilloscope by connecting the red lead to point C and the black lead to point Q as seen in Fig. 8. The voltage source is 70 V here instead of the 4 V amplitude described in your lab manual. Compare your waveform to Fig. 4 of your lab manual.

Figure 6. The oscilloscope measures the voltage drop across the 82 mH inductor.
Figure 7. The waveform of the voltage drop across the 8.2 mH inductor in the RL circuit.

Figure 8. The voltage is measured across point Q (red lead) and point C (black lead) which are the input lead points from the function generator. The voltage measured is from the voltage source (from the function generator). The applied voltage is 70 V instead of the 4 V described in the lab manual.
Repeat the experiment by adding an iron core inside the inductor as seen in Fig. 9. In Fig. 9 the voltage drop is measured across the 100 Ω resistor, but you can see that the inductance has changed based on the shape of the waveform. To get a waveform that completes the cycle to the maximum and a minimum values, the frequency was adjusted to 165.9 Hz as seen in Fig. 10. You should adjust your signal frequency to whatever works best with your iron core. Using your value for the resistor as R=100 Ω, calculate the value of the inductance using your measured value of the time constant. How does it compare to the inductance value without the iron core (8.2 mH)? Thinking back to the RC Circuits lab, which version (the Pasco Interface box or the function generator with oscilloscope) do you prefer to use and why?

Figure 9. An iron core is added inside the inductor, and the voltage drop is measured across the 100 Ω resistor.

Figure 10. An iron core is added inside the inductor, and the frequency of the function generator is adjusted to achieve a waveform that reaches a maximum and minimum.