Lab assignments –

Week 2.1 (Thursday) in Tellegen Hall

In this lab in week 2.1, you will analyze and test two assignments in the lab as follows:

- A second-order circuit (a series RLC circuit)
- AC-DC rectifier using one diode

Assignment 1: Second-order circuit (a series RLC circuit)

You already simulated the circuit below in LTSpice. In the lab you will build the same circuit and then compare your lab results with your simulation results in LTSPice.

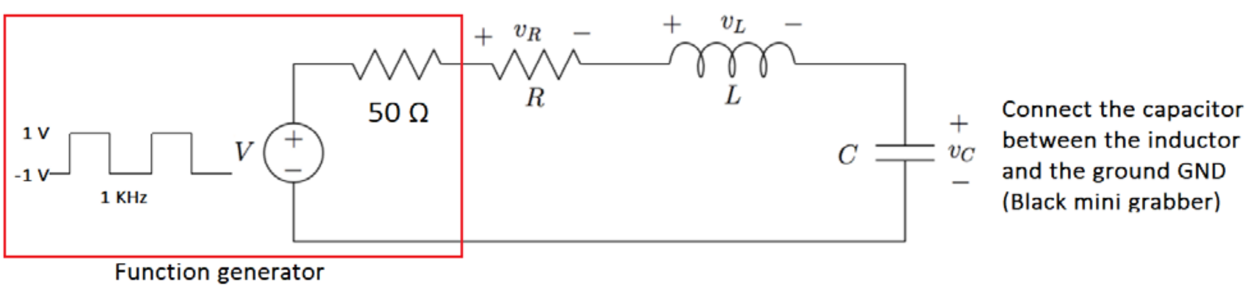

Fig 1. Series RLC circuit with a square wave voltage source.

Consider the RLC circuit shown in Figure 1 (C=100 nF, L=1 mH).

- Calculate the value of the resonant frequency ω_0 (rad/s) and f_0 (Hz).
- Assume that the function generator has an internal resistance of 50 Ω. In Figure 1, the resistance R is in series with the internal resistance of function generator 50 Ω. In other words, the equivalent resistance of this circuit is R+50 Ω.
    - Calculate the value for the resistance R where the damping factor (α) is equal to ω_0 (rad/s).
    - Calculate the value for the resistance R where the damping factor (α) is equal to 0.25*ω_0 (rad/s).

- Calculate the value for the resistance R where the damping factor (α) is equal to 5*ω_0 (rad/s).

Start to build and test the RLC circuit. Since the function generator has an internal resistance of 50 Ω, in the lab you need to consider it. As an example, if you want an equivalent resistance of 150 Ω, you need to connect a 100 Ω resistance to the function generator (since the function generator has a 50 Ω internal resistance). On the function generator, set the input square wave voltage with a peak-to-peak voltage of 2 V (-1 to +1 V) with the frequency of 1 KHz. Use a BNC (male) to clip minigrabber cable to connect the function generator to your RLC circuit (note: the black minigrabber is the ground). With an oscilloscope probe, measure the voltage across the capacitor using the oscilloscope:

- Measure the voltage across the capacitor using the value of R where the damping factor (α) is equal to ω_0 (rad/s). Solder R, L, and C in series together (according to Figure 1).
- Measure the voltage across the capacitor using the value of R where the damping factor (α) is equal to 0.25*ω_0 (rad/s).
- Measure the voltage across the capacitor using the value of R where the damping factor (α) is equal to 5*ω_0 (rad/s).
- Compare your simulation results and lab results for the previous three cases with three different values for R (overdamped, underdamped and critically damped).
- For the underdamped case, obtain the value of the damped natural frequency ω_d. Then, give the damped natural frequency from both your simulation results as well as your lab measurements from the oscilloscope. Does the damped natural frequency from your simulation results match the value from the measurements?

Assignment 2: AC-DC rectifier using one diode

You already simulated the AC-DC rectifier circuit below in LTSpice. In the lab you will build the same circuit and then compare your lab results with your simulation results in LTSpice.

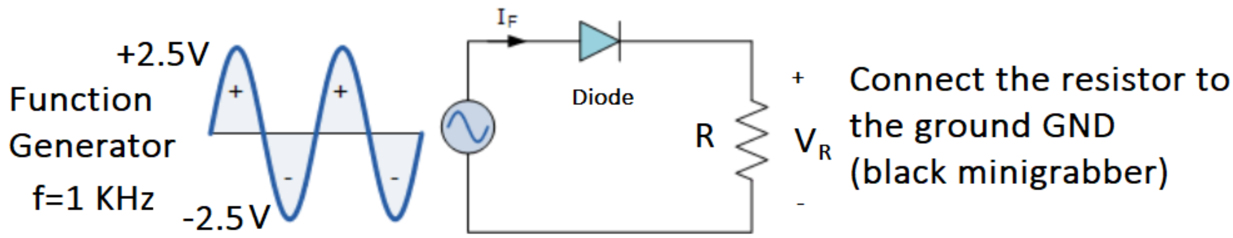

Fig 2. AC-DC rectifier using one diode and a resistor

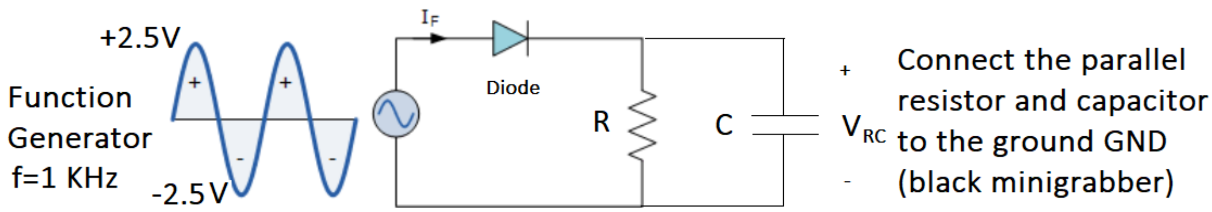

Fig 3. AC-DC rectifier using one diode, a resistor, and a capacitor.

Figure 2 shows an AC-DC rectifier/converter using one diode and a resistor (R=10 KΩ). Figure 3 shows an AC-DC rectifier using one diode 1N4148, a resistor (R=10 KΩ), and a capacitor (C=100 nF).

BNC male to minigrabber (when connected to the function generator, the black minigrabber is the ground)

Tektronix Oscilloscope Probe

Start to build and then test the above two circuits. The input voltage is an AC sinusoidal wave with a peak-to-peak voltage of 5 V (-2.5 to +2.5 V) with the frequency of 1 KHz. Use a BNC (male) to clip minigrabber cable to connect the function generator to your RC circuit (note: the black minigrabber is the ground).

- Measure the voltage across the resistor V_R in the circuit shown in Fig. 2. Does the lab measurements match your simulation results in LTSpice?

- What is the value of the forward voltage for the diode, which you use in the lab?
- Measure the voltage across the parallel resistor and capacitor V_{RC} in the circuit shown in Fig. 3. Does the lab measurements match your simulation results in LTSpice?
- Repeat the measurements where you use a 20 KΩ resistor (instead of a 10 KΩ resistor). What is the impact of the value of the resistance on the output DC voltage?