CHAPTER 4

Oncampus Course Lab Week 1.8: Microphone Amplifier Part 2

4.1 Study goals

This course lab addresses the transient behavior of a resistor-capacitor (RC) and a resistor-inductor (RL) circuit. At the end of this course lab, you will be able to:

1. Test the performance of the previously built microphone amplifier using a square wave signal as input for various range of input frequencies,
2. Observe and describe the transient behavior of a RC circuit and collect all the relevant measurement data,
3. Observe and describe the transient behavior of a RL circuit and collect all the relevant measurement data,

4.2 Assignment

Carry out the following three steps:

4.2.1 Step 1: Testing of the microphone amplifier circuit using a square wave as input

- Connect the input of the microphone amplifier to a function (signal) generator [note: in order to connect the function generator to the circuit, use the BNC to mini-grabber cable, and Not the oscilloscope probe],
- Set the amplitude of the input square wave to the peak-to-peak voltage of 1 V (+0.5 and -0.5 V) [note: if you face questions about the use of function generator, see Appendix K in EE1L1 Brightspace in Appendices All, or search it on the internet]

4.2.2 Step 2: Observe and describe the transient behavior of a RC circuit

- Connect the RC circuit (R and C in series) to the output of the microphone amplifier circuits [note: you are given two capacitors of 150 nF and one single resistor of 2200 Ω]
- For the signal generator, use a 200 Hz square wave and adjust the voltage of the signal generator so that the output voltage signal of the amplifier circuit (so across the resistor and capacitor) will be 3 Vpp (+1,5V and -1,5V).
- For three combinations of the capacitors and resistance (R in series with C, R in series with 2C (2C are in parallel) and R in series with 2C (2C are in series)), measure and draw (sketch the curves of) the voltage versus time across the capacitor(s) as well as the resistor. Note that you may need to adjust the input frequency to see the full transient in the oscilloscope.

Pay attention to the following notes:

1. With the physical inspection, check if you use a polarized or a non-polarized capacitor (how do you do this check?). In any circuit, if you use a polarized capacitor, you shall always mind the polarity.
2. For the oscilloscope settings, you can start to use these initial settings: CH1 and CH 2: 1,00 V div vertical scale; 1,00 millisecond div horizontal scale, however bear in mind that in order to observe the whole transient you may need to further adjust the time period and amplitude settings on the oscilloscope.
3. In each voltage curve, indicate the time at which the voltage reaches 36.8% and 63.2% of its final steady-state value. How do you obtain the time constant from your measurement results?

Please keep (save) these output measured values of RC circuit for the coming online session in week 8 where you will carry out some analysis about the measured results during this lab. For your convenience, it is suggested to take a photo of the oscilloscope screen using your mobile phone.

*Make sure you properly solder the capacitor and resistor in the circuit.

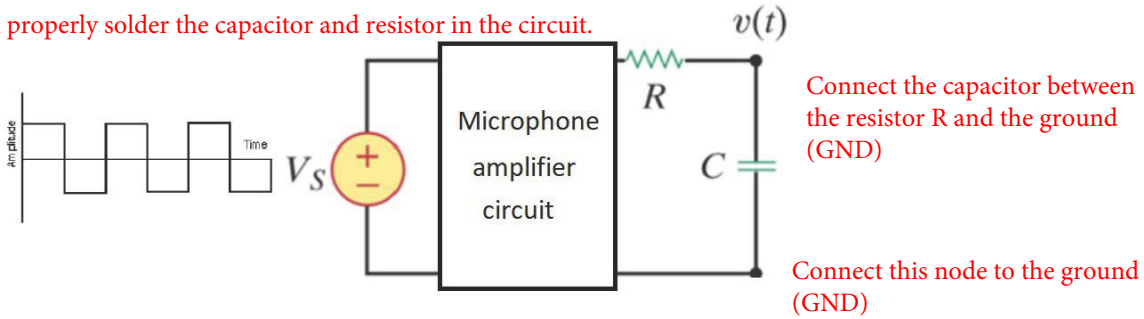


Figure 4.1: Transient behavior of a RC circuit.

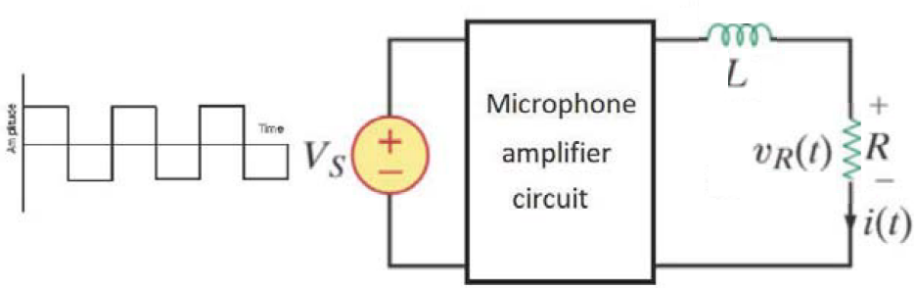
4.2.3 Step 3: Observe and describe the transient behavior of a RL circuit

- Connect the RL circuit to the output of the microphone amplifier circuits
  note: you are given two inductors of 1 mH and one resistor of 150 Ω
- For the signal generator, use a 10 KHz square wave and adjust the voltage of the signal generator so that the output signal of the amplifier circuit (so across resistor and inductor) will be 3 Vpp (+1,5V and -1,5V)
- For three combinations of the inductors and resistances (R in series with L, R in series with 2L (2L are in parallel) and R in series with 2L (2L are in series)) measure and then draw (sketch the curves) of the voltage across the resistor [note 1: For the oscilloscope settings, you can start to use these initial settings: CH1 and CH 2: 1,00 V div; 25 microsecond div, however bear in mind that in order to observe the whole transient you may need to further adjust the time period and amplitude settings on the oscilloscope.][Note 2: In each voltage curve, indicate the time at which the voltage reaches 36.8% and 63.2% of its final value.] How do you obtain the time constant from your measurement results?
- Please keep (save) these output measured values of RL circuit.
  *Note: To obtain the current, you must measure the voltage across the resistor (see Figure 4.2).

4.3 Analysis of RC & RL circuit's transient behavior

Once you finish with the previous three steps, using these measurement results you will be able to formulate and analyze the transient behaviors of a RC and a RL circuit.

*Make sure you properly solder the inductor and resistor in the circuit.



*Connect the resistor R between L and the ground (GND)

*Connect this node to the ground (GND)

Figure 4.2: Transient behavior of a RL circuit.

*Measure the voltage across the resistor.

- Evaluate the transient behavior of a RC circuit,
- Evaluate the transient behavior of a RL circuit

4.3.1 Question 1: RC circuit

For the previously-measured three combinations of the capacitors and resistance (R in series with C, R in series with 2C (2C are in parallel) and R in series with 2C (2C are in series)),

- Obtain the values of the time constant (how do you calculate the time constant using the measured voltage curves?)
- Give the equation for the voltage across the capacitors during both charging and discharging processes. Explain how the voltage varies during the transient and in specific calculate to what extent the voltage sharply changes at the rising edge and falling edge of the square wave (mind the initial conditions!). Afterwards, compare the results from the three combination circuits.
- Give the equation of the current through the resistor during both charging and discharging process. Explain how the current varies during the transient and then compare the results from the three combination circuits.

4.3.2 Question 2: RL circuit

For the previously-measured three combinations of the inductors and resistances (R in series with L, R in series with 2L (2L are in parallel) and R in series with 2L (2L are in series)),

- Obtain the values of the time constant.
- Give the equation for the voltage across the inductor. Explain how the voltage varies during the transient and in specific calculate to what extent the voltage sharply changes at the rising

Mini-grabbers

Probe (note: make sure you check attenuation (1x or 10x) on both probe and oscilloscope channel settings). You must read the value of attenuation on the probe which you use.