Name:	Lab section:	Lab task: _____ /10

Lab 4: Passive Filters

INTRODUCTION:

In this lab, you will apply your knowledge on AC circuit analysis to some basic circuits with some resistors and capacitors. The objective here is to relate theoretical predictions of the frequency response of passive filters with observations from an oscilloscope. At the end of this lab, you will apply your knowledge of passive filters to a real application involving simple audio processing.

Learning outcomes

- ☐ Relate the measured frequency response on an oscilloscope to theoretical predictions
- ☐ Apply filters to perform simple audio processing

REQUIRED MATERIALS:

Hardware:

1) Digital multimeter (DMM)
2) Cathode ray oscilloscope (CRO)
3) Signal generator
4) MP3 player
5) Loudspeaker

Parts:

1) Resistor (300Ω, 3kΩ)
2) Capacitor (6.8 nF)
3) Inductor (10 mH)
4) Breadboard

Lab Task 1

Connect the output of a signal generator directly to the CRO. Set the frequency to about 1 kHz (sine wave) and adjust the amplitude until it is **1V** (zero-to-peak) on the CRO.

a) Now, with the output of the signal generator still connected to the CRO, use another cable to connect the same output across a resistor with a value closest to 50Ω.

What is the voltage (zero-to-peak) across the 50 Ω resistor?

b) Now, try the same thing with a 3 kΩ resistor.

What is the voltage (zero-to-peak) across the 3 kΩ resistor?

c) The difference between the value measured between a) and b) is:

1. Measurement error
2. Source resistance in the signal generator
3. Source resistance in the CRO

Option A: 1 only
Option B: 2 only
Option C: 3 only

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Lab Task 2

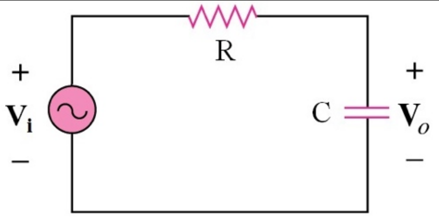

Fig 1: Schematic of a RC circuit.

Build the circuit in **Fig 1** on the breadboard, where R = 3 kΩ and C = 6.8 nF. Set V_i to have an amplitude of 10V and do not change this afterwards. Measure V_o on the CRO at the different frequencies listed in Table 1. Start from the lowest frequency listed in the table and increase the frequency till you reach the highest frequency listed in the table.

Take note of the phase of V_o relative to V_i at the lowest, highest and cutoff frequencies.

Table 1: Measurements of frequency response for circuit of **Fig 1**

f	***Measured f***	**V_o**	***Phase (V_o/V_i)*** ***by estimation***
250 Hz			
500 Hz			
1 kHz			
2 kHz			
4 kHz			
8 kHz			
16 kHz			
32 kHz			
64 kHz			
128 kHz			
256 kHz			
512 kHz			

Plot your results of $|V_o/V_i|$ vs. f/f_c on a **log-log graph**. Save time by computing $|V_o/V_i|$ and f/f_c directly on Excel. By using Excel, you can select the option to plot the results using a log-log scale without having to individually convert each data point manual to $\log_{10}$.

Show your graph and results to the instructor when getting marked (no graph, no marks)

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Lab Task 3

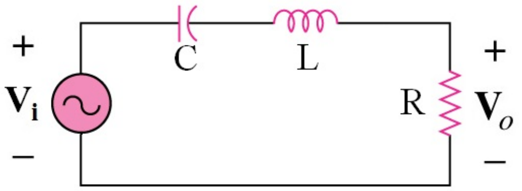

Fig 2: Schematic of a RLC circuit.

Build the circuit in **Fig 2** on the breadboard, where R = 300Ω, L = 10mH and C = 6.8nF. Set V_i to have an amplitude of 10V and do not change this afterwards. Measure V_o (the voltage across R) on the CRO at the different frequencies listed in Table 2. Start from the lowest frequency listed in the table and increase the frequency till you reach the lowest frequency listed in the table.

Take note of the phase of V_o relative to V_i at the lowest, highest, and resonant frequencies.

Table 2: Measurements of frequency response for circuit of **Fig 2**

f	***Measured f***	$\boldsymbol{V_o}$	***Phase (V_o/V_i)*** ***by estimation***
1 kHz			
4 kHz			
10 kHz			
12.5 kHz			
15.5 kHz			
17 kHz			
18 kHz			
19.5 kHz			
21 kHz			
22.5 kHz			
24 kHz			
28 kHz			
38 kHz			
90 kHz			
450 kHz			

Plot your results of $|V_o/V_i|$ vs. f/f_c on a **log-log graph**. Save time by computing $|V_o/V_i|$ and f/f_c directly on Excel. By using Excel, you can select the option to plot the results using a log-log scale without having to individually convert each data point manual to $\log_{10}$.

Show your graph and results to the instructor when getting marked (no graph, no marks) _____ / **3**

Lab Task 4

Build a low pass filter (RC circuit) with a cut off frequency around 120 Hz on the breadboard. Since 120 Hz cut off frequency is rather low, you should choose the largest capacitor available in the lab to minimize the resistance needed to obtain such a low cut off frequency. You will use this filter clean up the 10 kHz noise that is corrupting the music provided to you as an MP3 file for download.

a) First play the music from your MP3 player directly to the loudspeaker.

b) Now supply the input of the filter circuit with the output of your MP3 player. The output of your filter circuit should go to the input of the loudspeakers.

If two signals of the same strength are applied to the input of the filter at the cut off frequency (f_c) and at 10 kHz, at the output of the filter we will expect that the signal at 10 kHz relative to the signal at f_c is:

☐ Reduced by around a factor of 10
☐ Reduced by around a factor of 100
☐ Increased by around a factor of 10
☐ No different

Chosen value of R:

Chosen value of C:

Calculated value of f_c based on chosen values of R and C:

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