print name (first last): ________________________

course: ECET 337 2025-07-26

lab date (mo/day/yr): ________________________

lab section (day time): ________________________

instructor: ________________________

LC Low Pass Filter

Perlab Calculations

_____ 1. LC Design (10%)

_____ 2. LC Transfer Function (10%)

Performance Checks

			In lab	or	Late
_____	1.	DC output	(36%	or	18%)
_____	3.	Frequency response	(44%	or	22%)

Lab Report Scoresheet

Prelab initial submission (on time, with calculations, complete) … (20%)→ __________

All required signed ***Performance check offs*** ……………………………… (80%)→ ___________

Total (100%)→ ___________

Comments:

Prelab Activity:

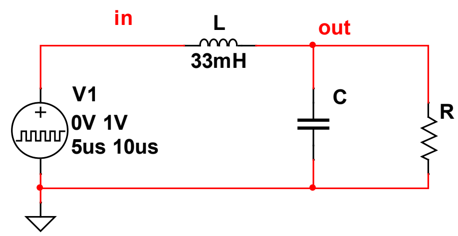

Figure 1 LC low pass filter

The purpose of a low pass filter is to pass the DC part of the input signal, and to attenuate (block) any variations or transients. For the circuit in Figure 1, the input goes from 0 V to 1 V, spending half of its time at 0 V and half at 1 V. This makes the average value, V_{DC} = 500 mV. That value should be measured across R with a DC volt meter or oscilloscope. The 100 kHz square wave at the input has V_{pp} = 1 V_{pp}. Little or none of that transient variation should be measured as V_{pp} across R with the oscilloscope. Only a smooth flat line should be displayed across R.

1. Design an LC low pass filter using a 33mH inductor. Record your calculations below.

Set f_o ~ 10 kHz. ω_o = ________ C_{theory} = ________

This may be an unusual capacitive value. The precise value of f_o is not critical as long as it is far above DC (0Hz) and far below the frequency at which the input varies. Select a capacitor that you have, and recalculate the $f_{o\ practical}$.

$C_{practical}$ = ________ $f_{o\ practical}$ =________

Calculate a value for the resistor that will make the filter *critically* damped. Use L = 33 mH and $C_{practical}$.

$\zeta_{critical}$ = _________ R = ___________

2. The transfer function for a second order low pass filter is $\frac{V_{out}}{E_{in}} = \frac{A_o\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$ Write the transfer function for your circuit, using the component values selected above.

$$\frac{V_{out}}{E_{in}} = \frac{\qquad}{s^2+\qquad s+\qquad}$$

Objectives

Verify the design of an LC low pass filter and compare it to a first order RL lag circuit.

Approach and Results

1. DC Output

a. Measure each component and record its value below *before* installing it into your circuit.

L = __________ C = __________ R = __________

b. Build the circuit in Figure 1. Assure that your build is neat and orderly, with labeled test points, and no *loops* or *jungles.* You are working near the bottom of the AM radio band. So short neat connections are necessary to not transmit or receive signals through the loops and jungles.

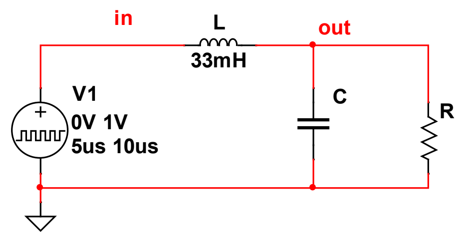

Figure 1 LC low pass filter

c. Set the generator to produce a square wave at 100 kHz, with the **TOP** = 1V and the **BASE** = 0 V, and a 50 % duty cycle.

d. Assure that both channels of the oscilloscope are DC coupled.

e. Be sure that the oscilloscope is properly accounting for the attenuation of the probes.

f. Connect CH1 to the input and CH3 to the output.

g. Adjust the vertical position of both channels so that their ground lines are one division up from the bottom of the screen.

h. Adjust the oscilloscope ~ 20 μs/div. This will display 20 cycles of the input, giving the filter's output time to charge up and stabilize. Adjust the vertical V/div so that the input covers at least half of the screen, but does not go over the top of the screen.

i. Adjust the output, CH3, V/div to be the same as the input, CH1 V/div. This allows a more obvious comparison.

j. Using the **MEASURE** function of the oscilloscope, also display the $V_{average}$ of the output.

k. Adjust the generator to each duty cycle indicated in Table 1. In the $V_{out\ pp}$ column, enter
same if the output ripple is about the same size as the input's V_{pp}
smaller if the output ripple is considerably smaller
tiny if the output is barely visible without changing any settings
none if you cannot see any variation on the output without changing settings

same if the *ripple* on the output is nearly as big as the input V_{pp},

Table 1 DC output

Duty cycle	$V_{DC\ out\ -\ theory}$	$V_{DC\ out\ –\ LC\ filter}$	$V_{pp\ out\ –\ mVpp}$
10			
30			
50			
70			
90			

l. How well did each circuit produce the correct DC?

Demonstrate the oscilloscope display, a sample screen and Table 1 to your lab instructor.

2. Damping

a. Return the duty cycle to 50%. Do not change the input frequency, the time/div, the V/div, and the position setting.

b. Set the oscilloscope trigger to start a new trace when the output crosses 0.1V going positive, single trace.

c. Adjust the oscilloscope's controls as necessary to show the proper transient response of a *critically* damped circuit at the output. You may have to start and stop the input , and readjust the oscilloscope controls to capture a good display. Capture this display to show to your instructor.

d. Triple the value of R. Calculate the damping of this circuit. ζ_{3*R} = _________

e. Capture this display to show to your instructor.

f. Cut the value of R to 1/3 of its original (critically damped) value. Calculate the damping of this circuit. $\zeta_{R/3}$ = _________

g. Capture this display to show to your instructor.

h. Return R to its original value.

3. Frequency Response

a. With the input at 100 kHz, 50% duty cycle, 0 V to 1 V, measure the *output* V_{DC}.
In the $V_{out\ pp}$ column, enter
same if the output ripple is about the same size as the input's V_{pp}
smaller if the output ripple is considerably smaller
tiny if the output is barely visible without changing any settings
none if you cannot see any variation on the output without changing settings

a. Change the frequency (only) to the value in the next row. Measure and record the *output* V_{DC} and V_{pp}.

b. Continue output measurements for all frequency values in Table 2.

Table 2 Frequency Response

Frequency kHz	$V_{out\ DC\ LC\ filter}$ V_{DC}	$V_{out\ pp\ LC\ filter}$ mV_{pp}
25		
50		
100		
200		
400		

c. If your microcontroller is to produce various DC values by producing a rectangular pulse and changing the duty cycle of an output pin, would it be better to create a 50 kHz rectangle or a 200 kHz wave? Why?

Demonstrate the oscilloscope display, the table and answer to questions 3c your lab instructor.