print name (first last): ________________________

course: ECET 337 2025/07/26

RC Laplace Design

Prelab Calculations

_____ 1. Circuit 1 (5%)

_____ 2. Circuit 2 (5%)

Performance Checks

		In lab	or	Late
_____	1. Circuit 1 *Simulation* Performance	(30%	or	15%)
_____	2. Circuit 2 *Hardware* Performance	(30%	or	15%)

Lab Scoresheet

Demonstration oscilloscope screen captures (10%) __________

All required signed ***Performance check offs*** .... (60%)→ ___________

Totatl performance grade %, (100%) → ___________

Comments:

Prelab Activity: Refer to the attached Design Summary

1. Design an RC and op amp circuit that will implement the following transfer function. The time constant, τ, is based on the month of your birthday. The gain amplitude, A, is the last nonzero digit of your student id.

Select the time constant from the table below, based on your birthday.

Month of your birthday	Time constant, τ, (μsec)
January & February	20
March, April, May	25
June & July	30
August, September, October	35
November, December	40

Your birth month _________ Your time constant = ____________

$\tau =$ ________μsec gain $A =$ _________

$$\frac{V_{\text{out}}}{E_{\text{in}}} = A \times \frac{1}{\tau s + 1}$$

Show all of your work below, and draw the schematic.

2. Design an RC and op amp circuit that will implement the following transfer function. Use the same time constant and gain as in question 1. Notice, the gain is *inverting*.

$\tau =$ ________μsec gain $A =$ _________

$$\frac{V_{\text{out}}}{E_{\text{in}}} = -A \times \frac{\tau s}{\tau s + 1}$$

Show all of your work below, and draw the schematic.

How does your circuit provide negative gain *without* loading down the RC network?

Objectives

Verify the design of two RC circuits given their transfer function.

Approach and Results

1. Circuit 1 – Simulation

Be *sure* that the captures submitted correspond to *your* measured results from section 2.

a. Simulate your design with Matlab's tf function. Place cursors to confirm A and τ. Enter the results in Table 1.

b. Capture the appropriate screens. Place data cursors to mark A and τ.

c. Simulate your design with Multisims arbitrary Laplace module, and Transient Analysis (not the oscilloscope). Place cursors to confirm A and τ. Enter the results in Table 1.

d. Capture the appropriate screens for your report,

e. Simulate your design with Multisim (Transient Analysis), using the R and C and the op amp amplifier you implemented with hardware. Place cursors to confirm A and τ. Enter the results in Table 1.

f. Capture the appropriate screens for your report.

Table 1 Circuit 1 performance

	Theory	Hardware	Matlab	Multisim Laplace	Multisim RC
A					
τ (μsec)					

Demonstrate the oscilloscope display, screen capture and Table 2 to your lab instructor.

2. Circuit 1 Hardware Verification

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

C = ___________ R = ___________ R_i = __________ R_f = ___________

b. Build the circuit you designed to implement

$$\frac{V_{\text{out}}}{E_{\text{in}}} = A \times \frac{1}{\tau s + 1}$$

c. *Before* connecting the power supplies to the op amp, set them to $\pm$ 5V as measured by a multimeter.

d. Assure that you have the correct pin out for the op amp. Reversing the power connections will damage the op amp.

e. Assure that your circuit is neat and orderly, with labeled test points, and no *loops* or *jungles*.

f. *Before* connecting the input signal to your circuit, *verify* with an oscilloscope that it is correct.

frequency = 2 kHz to provide $5\tau < \frac{T}{2}$

amplitude 0 V to 200 mV (base to top)

g. Adjust the oscilloscope to provide one to two cycles of the input, with the wave filling *most* of the *lower* two vertical divisions of the screen, then disable the signal.

h. Turn on the $\pm$ 5 V supplies to the op amp.

i. Connect the output from the function generator to the input of your circuit, then enable the function generator's output.

j. Measure the **Top** and the **Base** of the input from the generator by using the data provided by the oscilloscope's measure function. Adjust the function generator until these values are correct.

k. Display the circuit's output on the other channel of the oscilloscope. Adjust its **position** and **V/div** so that the output signal nearly fills the *upper* four vertical divisions of the screen.

l. Add the measurements for the **Top** and the **Base** of the output to the oscilloscope's measure function. Capture this display.

$v_{\text{out top}}$ = _________________ $v_{\text{out base}}$ = _________________

m. Calculate the gain, *A* and compare it to the specifications from prelab. Correct the circuit until there is less than 10% error.

$A_{measured}$ = __________ A_{spec} = ____________ error = __________

n. Using the procedures from the preceding lab, confirm τ. Capture waveforms with cursors to prove your data. Continue when there is no more than 10% error. Enter results in Table 1, above.

Table 1 Circuit 1 performance

	Theory	Hardware	Matlab	Multisim Laplace	Multisim RC
A					
τ (μsec)					

3. Circuit 2 Hardware Verification

a. Record the *actual* values of R = _________ C = _________ R_i = _______ R_f = ________

b. Using the procedures above, build and verify the performance of your circuit. Place cursors to confirm *A* and τ. Be sure to make enough screen captures to support your data. Enter the results in the first two columns of Table 2.

Table 2 Circuit 2 performance

	theory	Hardware
A		
τ (μsec)		

c. Capture the oscilloscope screen for your report.

Demonstrate the oscilloscope display, screen capture and Table 2 to your lab instructor.

Report

1. Submit the two schematics, the oscilloscope screen captures, the simulation screen captures, and the two tables. No purpose, or procedures are required.

2. Explain any differences among the three different simulation techniques and the hardware verification.

2. Compare the three different simulation techniques. Discuss:

ease of use
accuracy
other considerations

Which is your favorite technique and why?