ECE231-2021 Lab 1

Lab Report: Basic simulations with Spice

PRA Section: 0101

Date: 01/19/2021

Team Member 1 (First Last)*: Songeun You

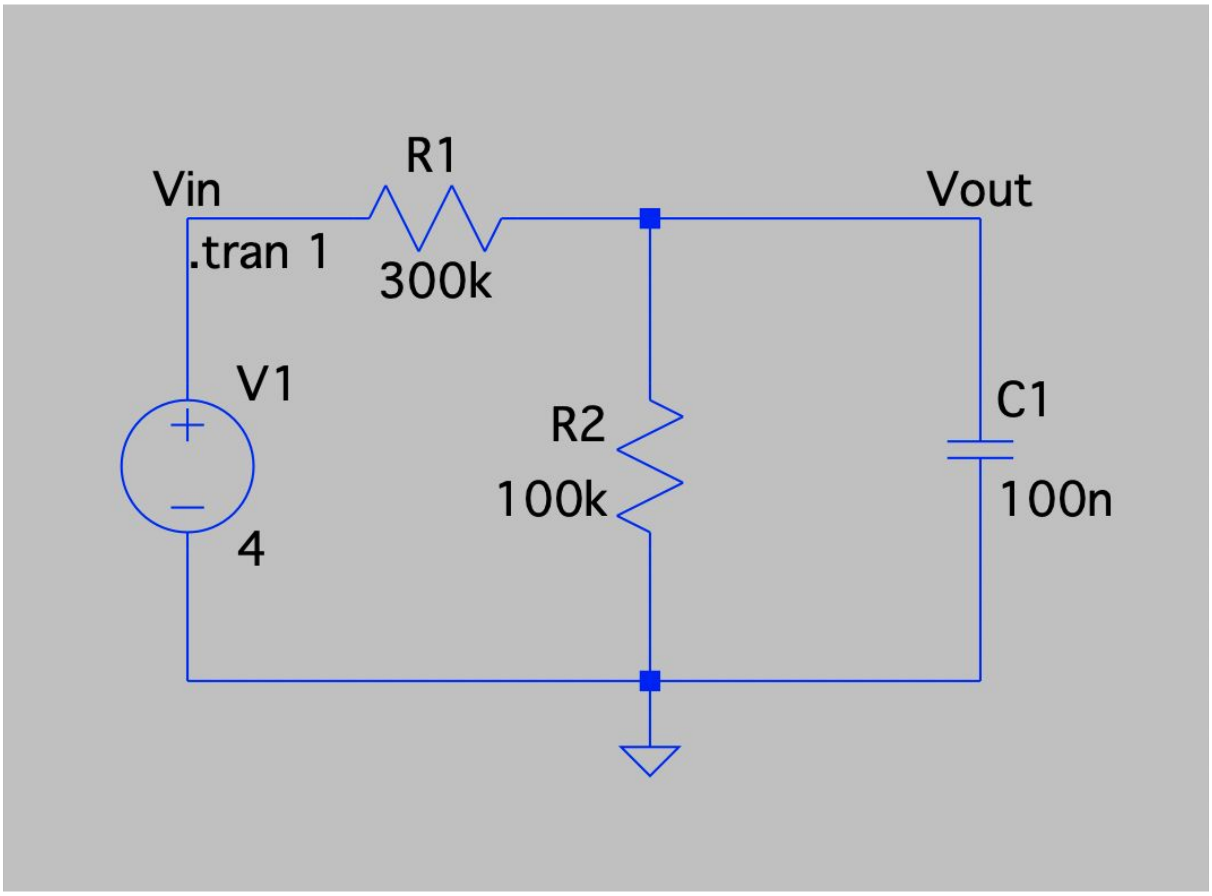
Team Member 2 (First Last)*: Deniz Uzun

*Must match with Quercus – no nicknames

ECE231_Lab1_PRA0101_You_Uzun.pdf

S1.1

· Show a screenshot of your circuit from Fig. 1.1:



· Provide the value of the DC source, resistors, and capacitors:

DC source: 4V

Resistor 1: 300kΩ

Resistor 2: 100kΩ

Capacitor 1: 100nF

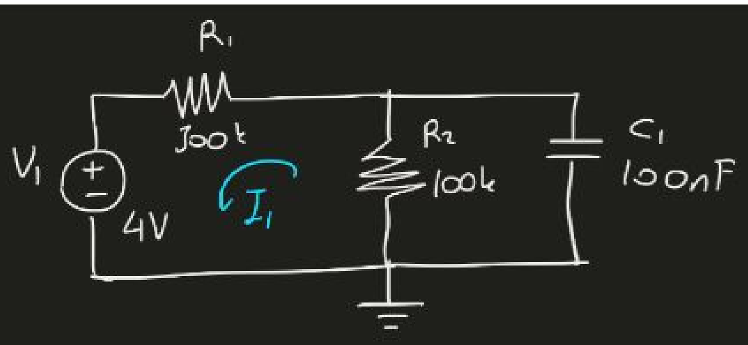
- Report the DC current and voltage of different nodes:

Vin: 4V, -10µA

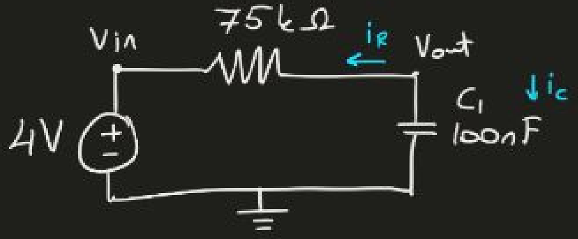
Vout: 1V, - 10µA

Ground Node: 0V, -10µA

- Compare your result with a hand-calculation:



$$R_{Total} = \frac{1}{\frac{1}{300 \cdot 10^3} + \frac{1}{100 \cdot 10^3}} = 75\ k\Omega$$



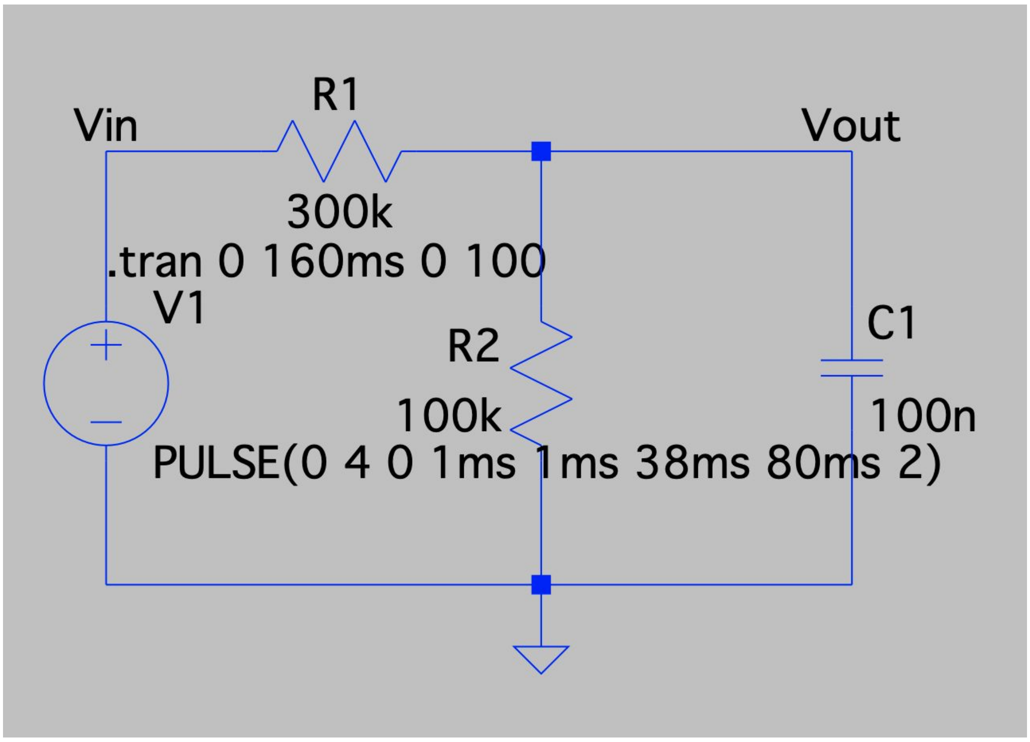
$$\underline{\underline{V_{in} = 4V}} \qquad \tau = RC = 7500\ \mu s = 7.5\ ms$$

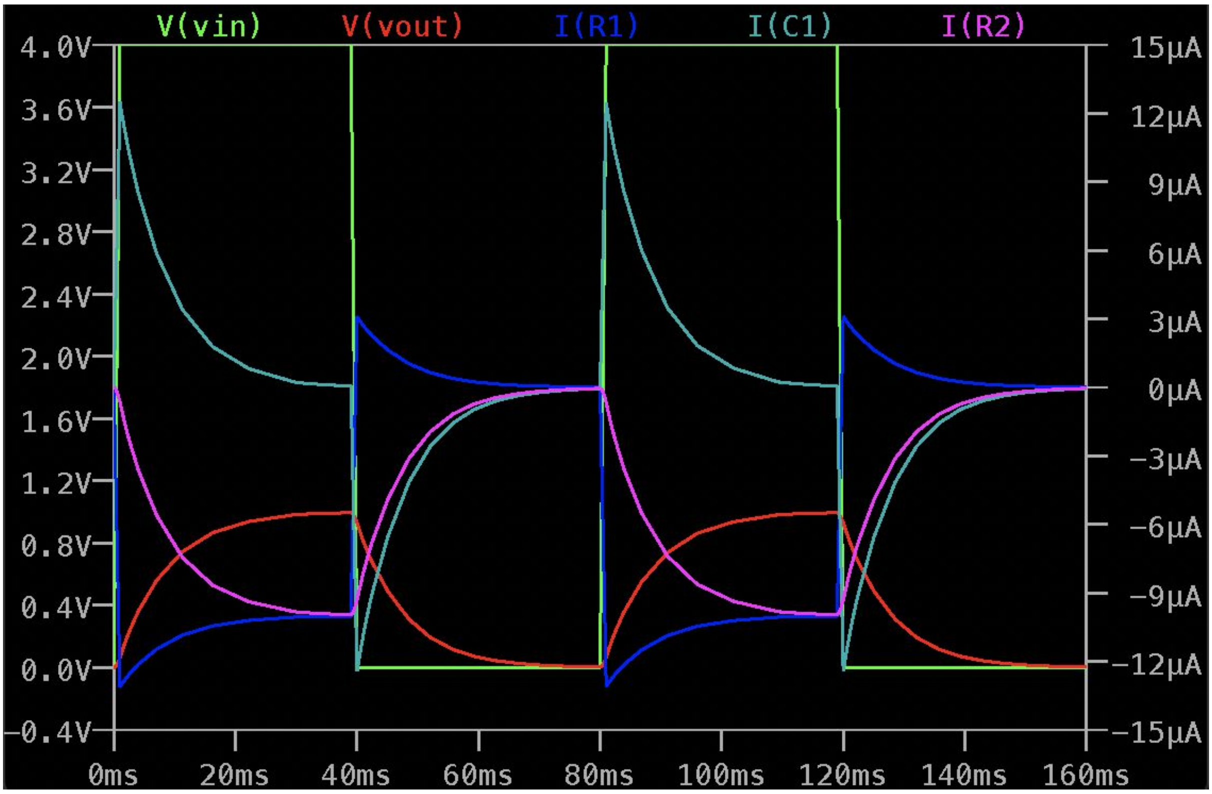
$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2} = 4 \frac{100k\Omega}{400k\Omega} = \underline{\underline{1V}}$$

$$-I_1 = I_{V_1} = I_{R_1} = I_{R_2} = \frac{V_1}{R_1 + R_2} = \frac{4}{400k\Omega} = \underline{\underline{10^{-5} A}}$$

S1.2

· Show a screenshot of your circuit from Fig. 1.2:





- Calculate the time constant of this circuit?

<u>First find total R: resistors are in parallel</u>

R_{total} = (300k x 100k) / (300k + 100k)

R_{total} = 75 kΩ

Calculate time constant

$\tau = RC$

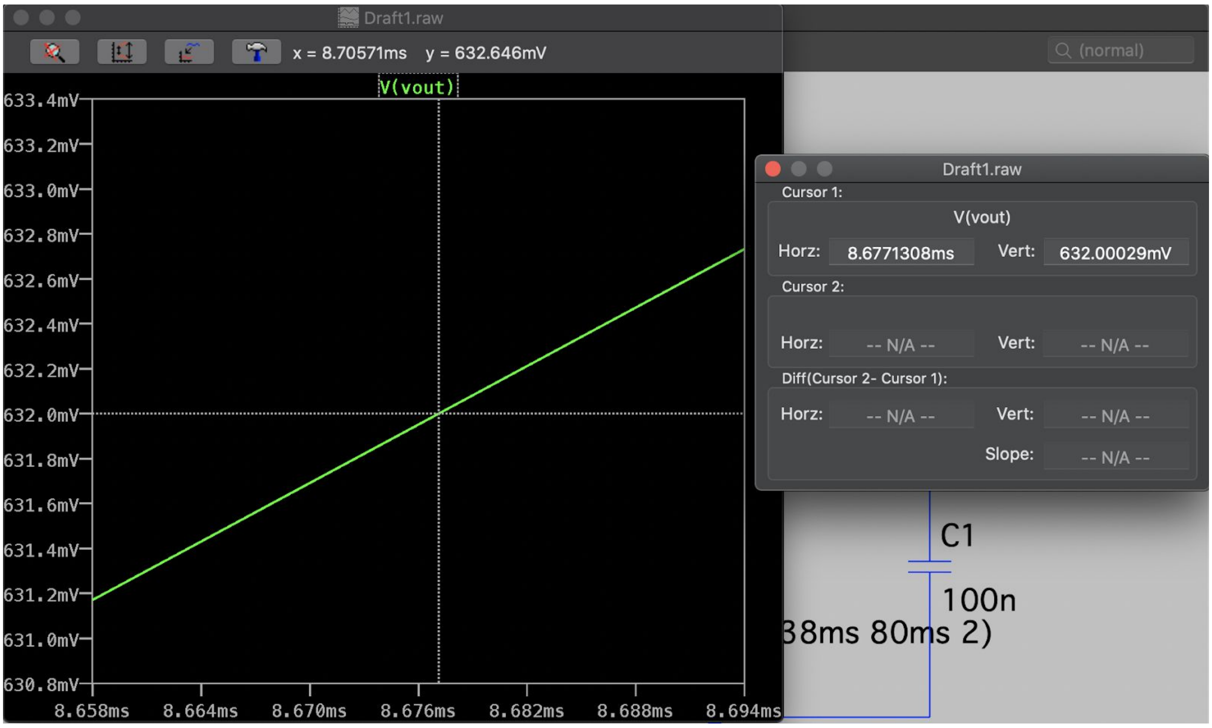
τ = 75 kΩ x 100nF

τ = 7.5 ms

· Show your measurement of the time constant of the circuit (simulation result):

V(out)=1-1/exp(-t/τ)

At t=τ V_out=0.632 V



· Justify the chosen Ton value for the input source:

With different values for Ton, the output waveform changes quite drastically. Lower Ton values result in a shorter waveform peak, with longer ramp up and ramp down periods. Higher Ton values result in a longer waveform peak, with shorter ramp up and ramp down periods.

· How would you modify your circuit to reduce the time constant by a factor of 2 (justify your answer with a simulation result)

V(out)=1-1/exp(-t/τ)

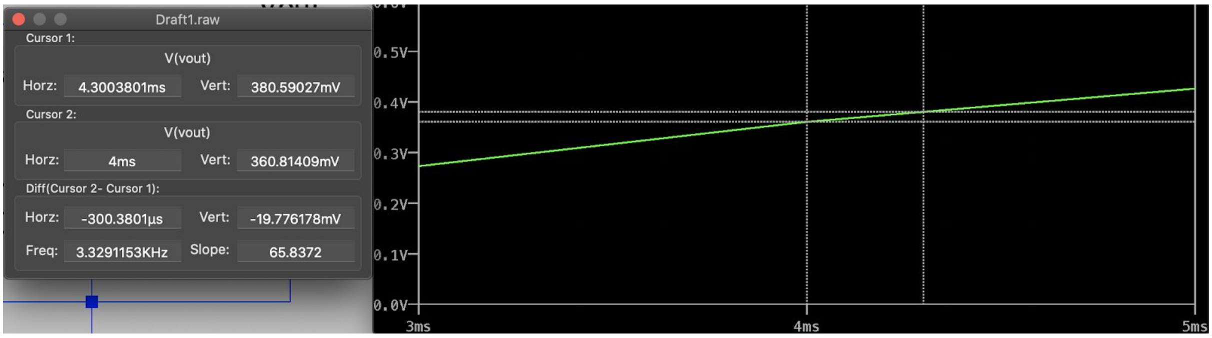
V_out+1=1/exp(-t/τ)

exp(-t/τ)=1/(V_out+1)

t/τ=-ln(1/(V_out+1))

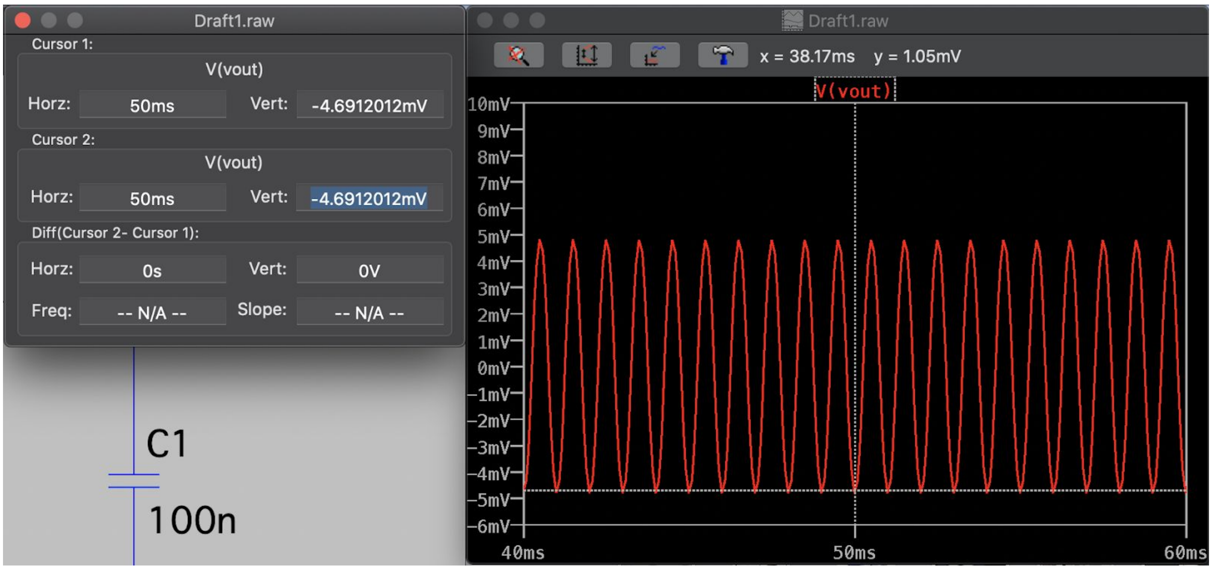
V_out=1-1/exp(½)=0.393469 V = 393.469 mV

We can change the V_out value to be 393.469 mV.



S1.3

· Plot the output waveform and measure its amplitude in steady-state:



Amplitude: 4.785215mV

· Use cursors to approximately measure the phase difference between the input and the output waveforms. Report this value.

peak of in → peak of out = 49.248392ms → 49.479726ms

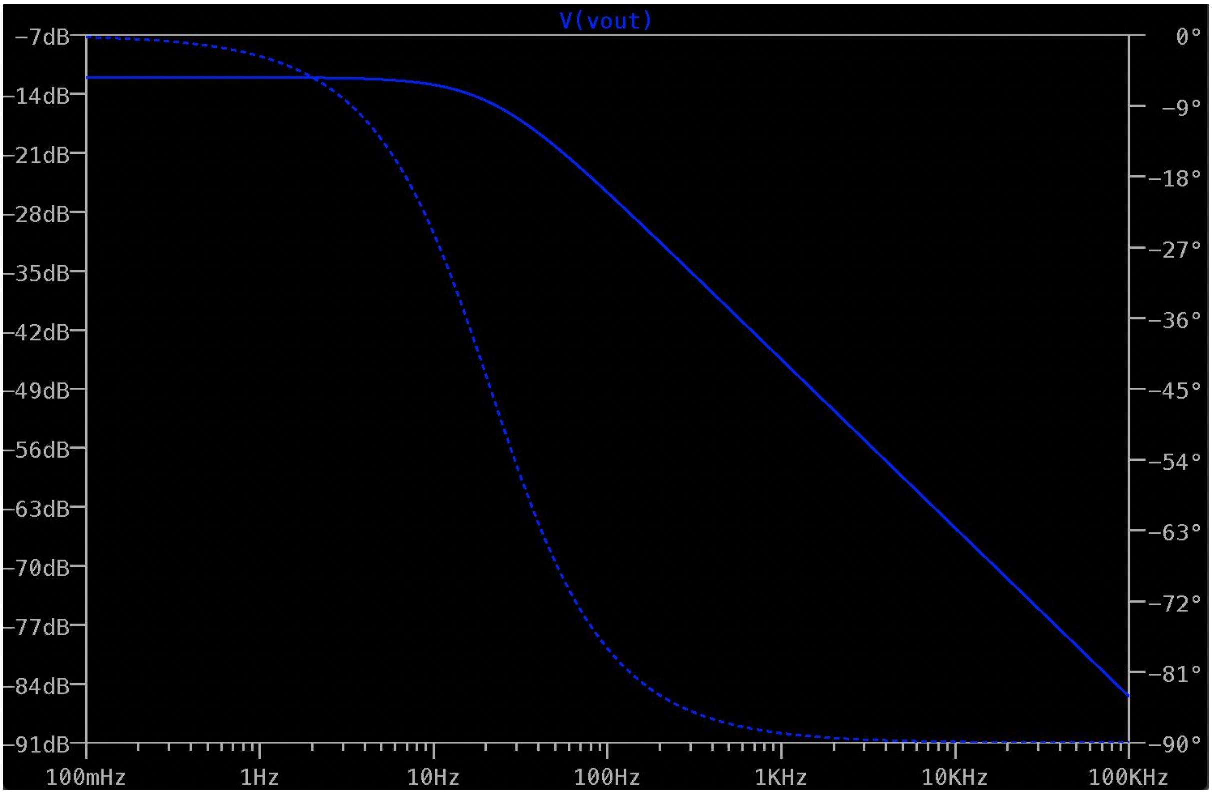
Time difference: 0.231334ms

Phase difference = (Time difference/time period)*360 degrees

Phase difference = 0.231334*1kHz*360 = 83.28 degrees

S1.4

· Plot the output voltage waveform:



· Justify and explain the output voltage magnitude and phase values at very low and very high frequencies.

At low frequencies, the AC output acts similar to a DC output (little fluctuation), thus it is easy for a capacitor to slowly charge up and maintain that charge over time. For this reason, the output voltage is high as the current goes to infinity.

At high frequencies the charges very quickly so it absorbs all the current it receives. Thus, the output voltage is low as the current in the rest of the circuit goes to 0.

With regard to the phase, the output voltage will be 90 degrees out of phase. We are measuring a sine waveform; the derivative will be a cos waveform (90 degrees out of phase).

· Measure amplitude and phase at f=1 kHz. Compare your results with the values obtained from the time-domain analysis of S.1.3.

Mag -45.507978dB **Phase** -88.784328°