Lab Report

Lab Session-1

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Aim:

To find out the output response of RC series circuit for transient and steady condition.

Components used:

Resistor(10KΩ), Capacitor(10nF), Function Generator, Oscilloscope, Bread board, wires.

Theory:

In the output response of a series RC circuit we have 3 cases, considering steady state condition;

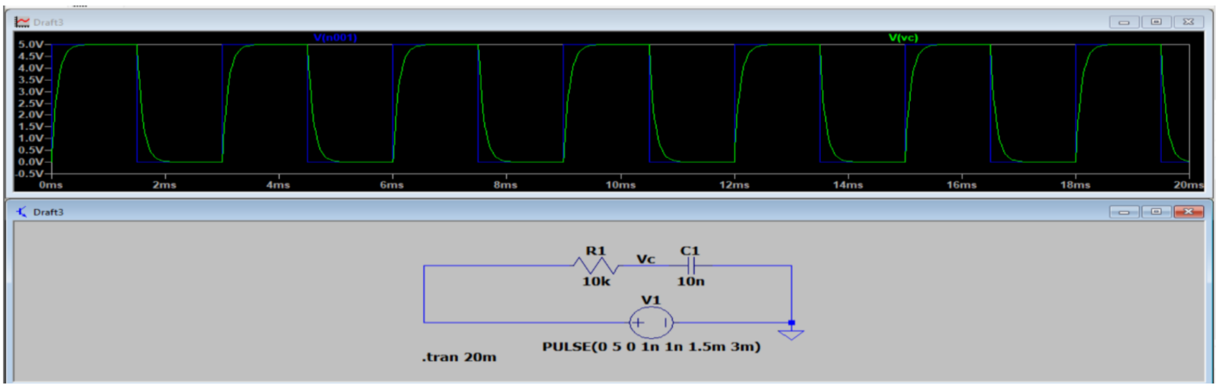
The formula for the voltage across capacitor in a series RC circuit is given by:

$V(t) = V_f + (V_i - V_f)\, e^{\frac{-t}{RC}}$

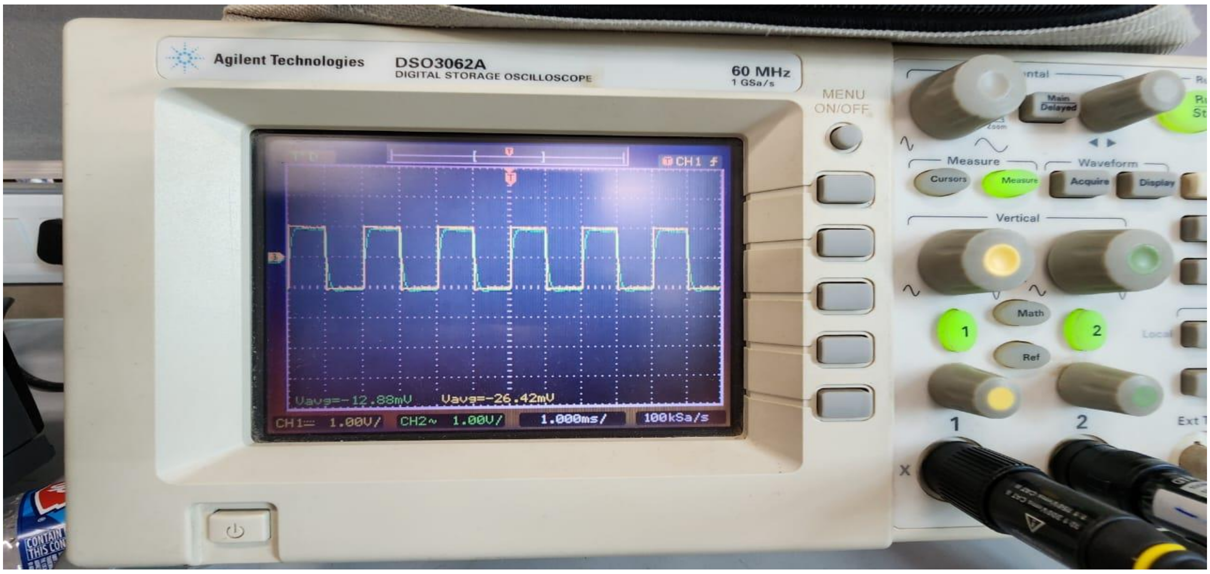
Case-1: T>>RC

For T>>RC , we have T/RC >>1,

So, as time proceeds $e^{\frac{-T}{RC}}$ is tending to zero, hence we get $V(T)=V_f$.



The LTspice model suggests that the during charging cycle the voltage across capacitor rises up to 5V and attains a constant value of 5V, Once the voltage source shuts off the capacitor discharges to zero, and the cycle continues.



We set up the RC circuit onto the breadboard using the resistor of 10kΩ and capacitor of 10nF. We power the circuit using a function generator. We send a square pulse of frequency 0.5kHz as input. We then find the voltage across capacitor by attaching channel 1 of the oscilloscope probe to one of the legs of the capacitor and channel 2 of the oscilloscope probe to the input probe of the function generator. So, we can plot the input and output waveform on the oscilloscope. Hence, we get the output response of the oscilloscope.

ERROR:

Vpp (output)(experimental)=1.33V

Vpp (output)(theoretical)=1.57V

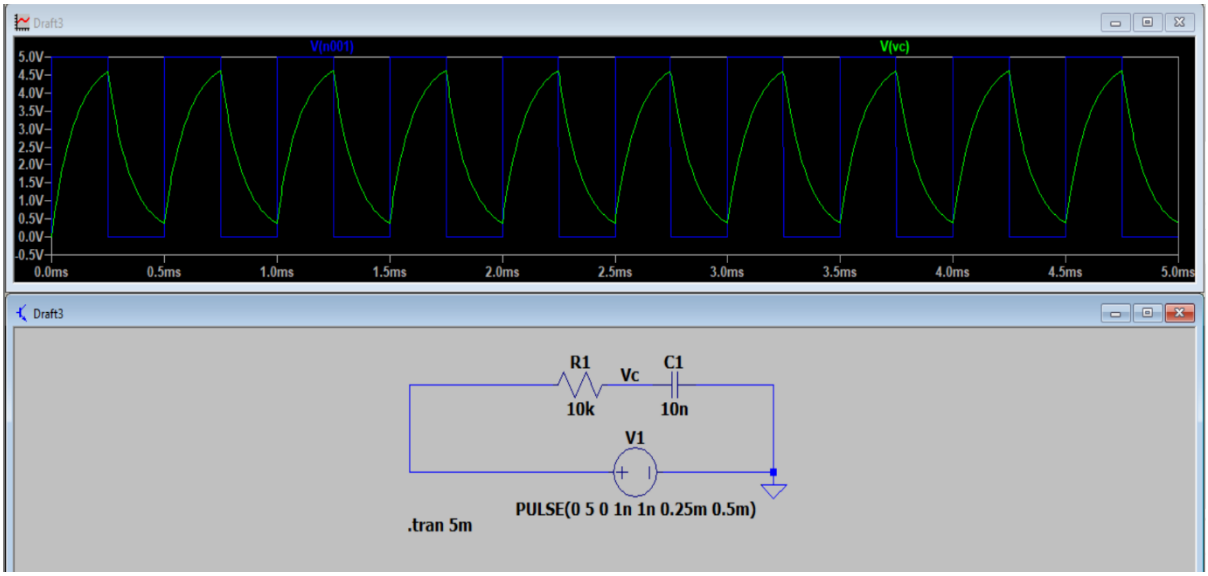
Error=15.33%

Case-2: T==RC

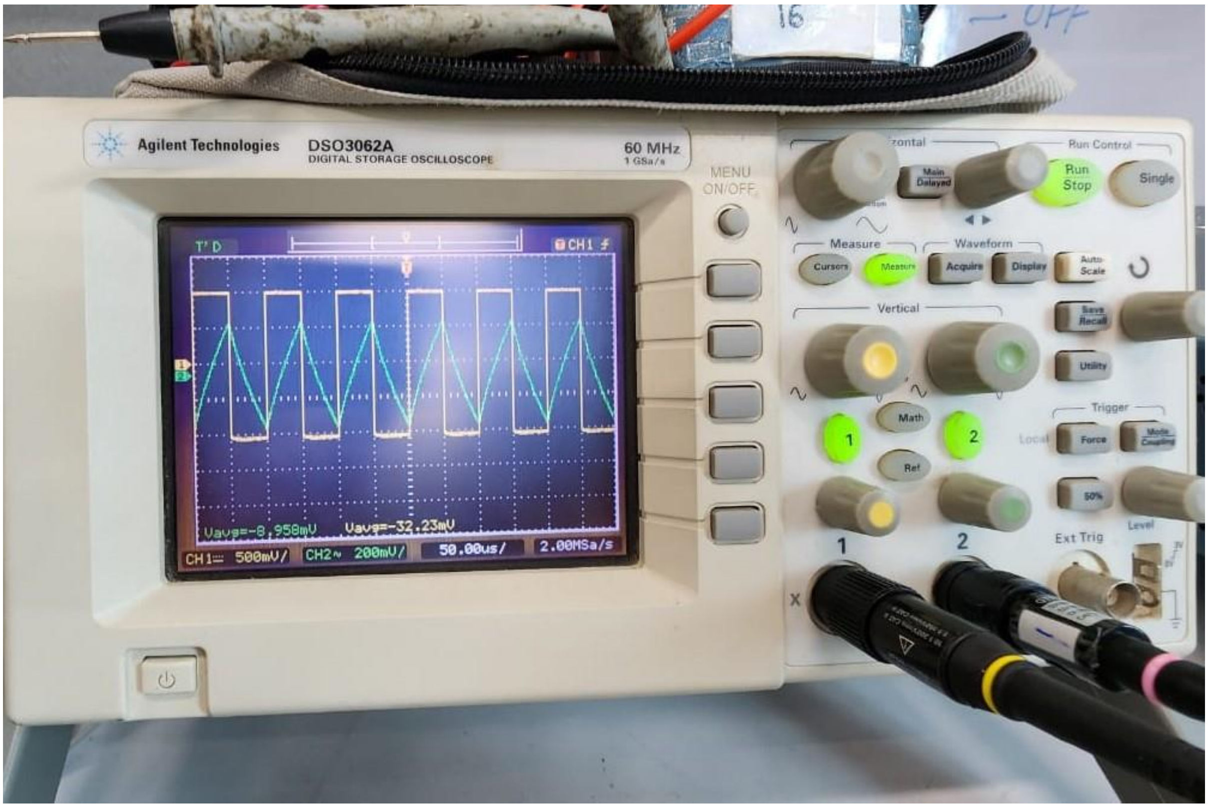
For T==RC, we get the steady state condition.

So, as time proceeds $e^{\frac{-T}{RC}}$ is tending to e^{-1} = 0.37, hence we get

$V(t)$ =V_f + (V_i - V_f) e^{-1}.



The model suggests that during the charging cycle, the capacitor gets charged exponentially and reaches to a maximum value equal to 0.37V_i + 0. 67V_f. The capacitor discharges exponentially to zero once the voltage source is switched off. This charging, discharging cycle continues.



We set up the RC circuit onto the breadboard using the resistor of 10kΩ and capacitor of 10nF. We power the circuit using a function generator. We send a square pulse of frequency 10kHz as input. We then find the voltage across capacitor by attaching channel 1 of the oscilloscope probe to one of the legs of the capacitor and channel 2 of the oscilloscope probe to the input probe of the function generator. So, we can plot the input and output waveform on the oscilloscope. Hence, we get the output response of the oscilloscope.

Vpp (output)(experimental)=5.382V

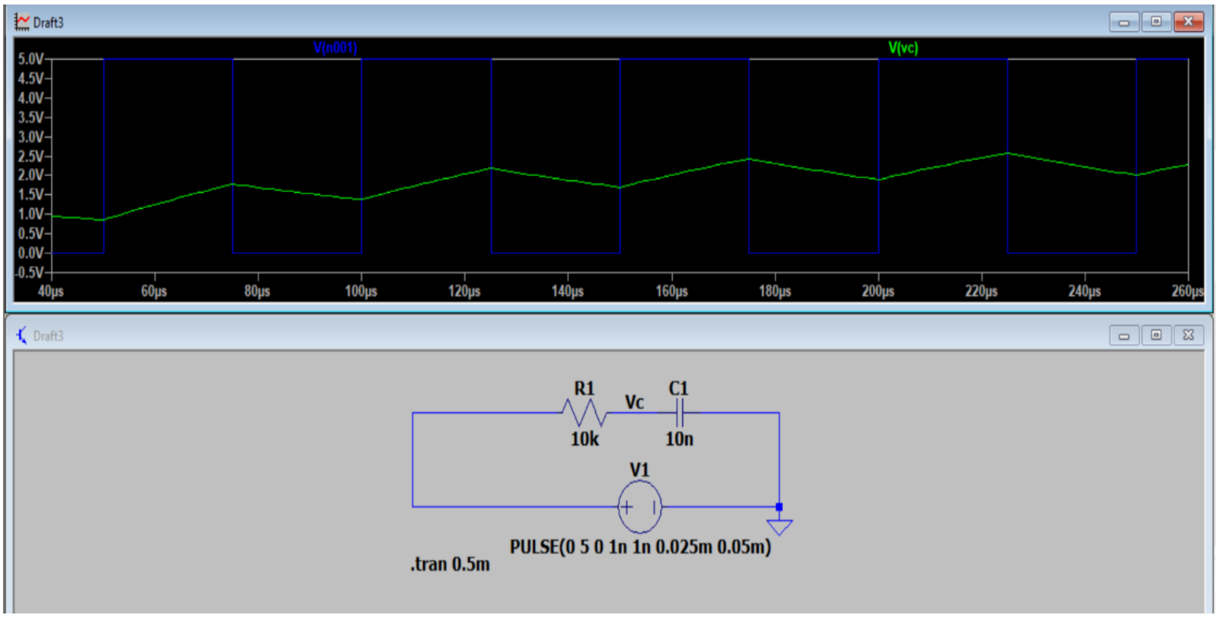
Vpp (output)(theoretical)=5.035V

Error=-6.89%

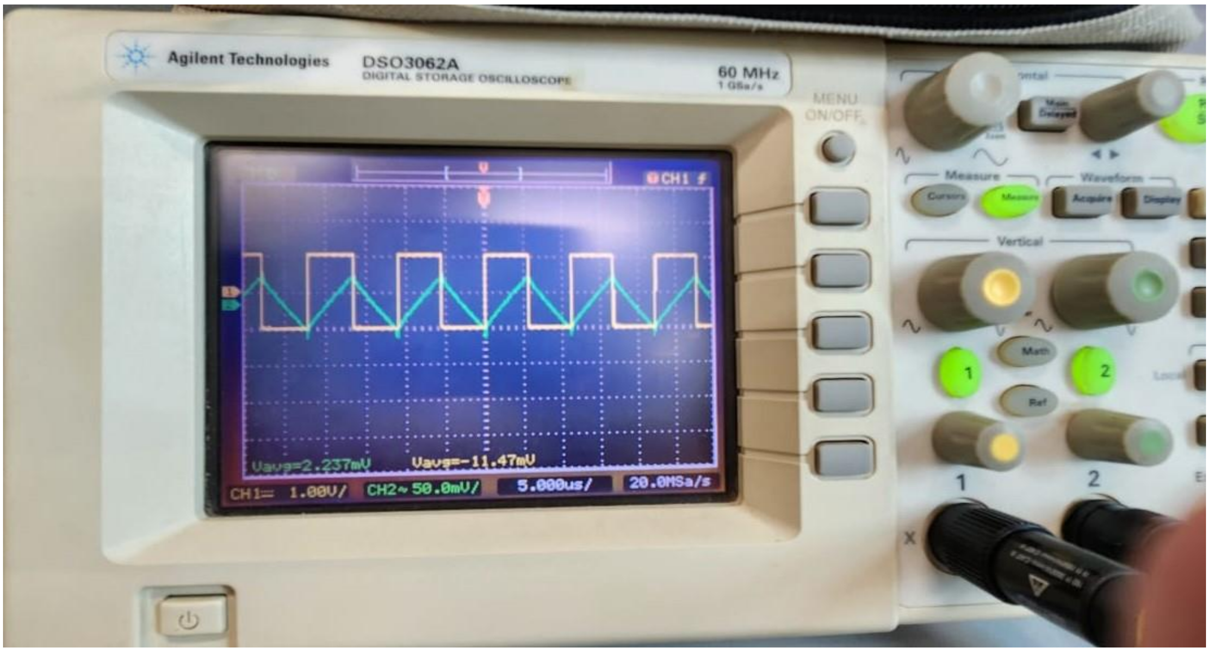
Case-3: T<<RC

For T<<RC, we have T/RC <<1,

So, as time proceeds $e^{\frac{-T}{RC}}$ is tending to one, hence we get $V(T)=V_i$.



The LTspice model suggests that the during charging cycle the voltage across capacitor rises to a certain intermediate value, this is because enough time is not there for the capacitor to charge to its maximum value. Even though the graph seems linear, it is not, it is an exponential graph. Once the voltage source shuts off the capacitor discharges exponentially to its initial value and this cycle repeats itself.



We set up the RC circuit onto the breadboard using the resistor of 10kΩ and capacitor of 10nF. We power the circuit using a function generator. We send a square pulse of frequency 100KHz as input. We then find the voltage across capacitor by attaching channel 1 of the oscilloscope probe to one of the legs of the capacitor and channel 2 of the oscilloscope probe to the input probe of the function generator. So, we can plot the input and output waveform on the oscilloscope. Hence, we get the output response of the oscilloscope.

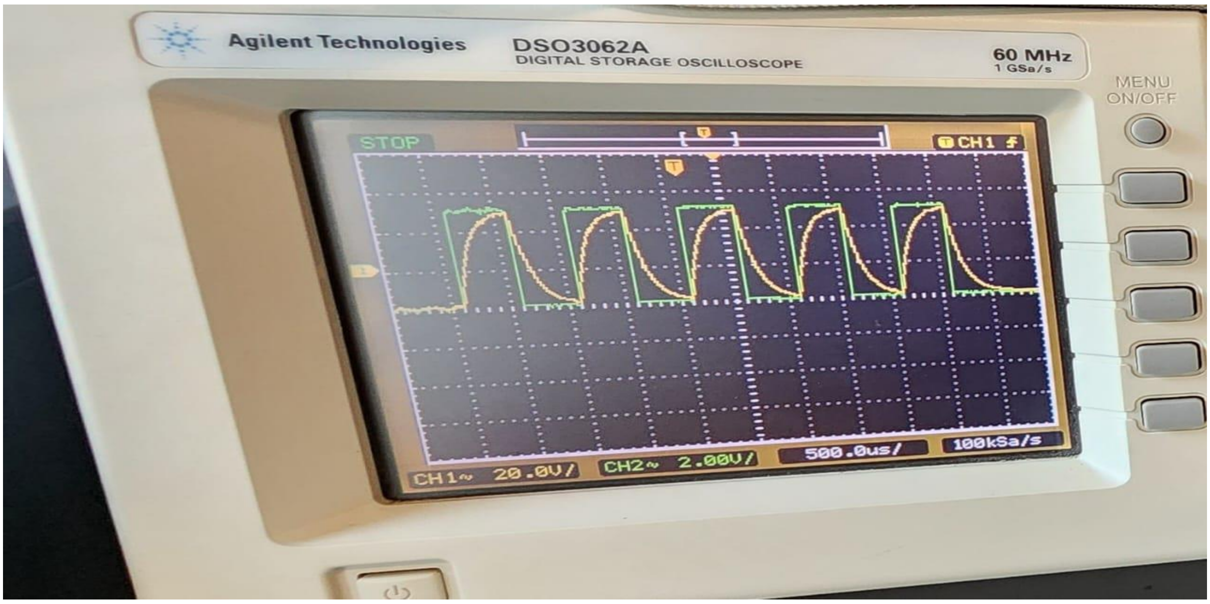
ERROR:

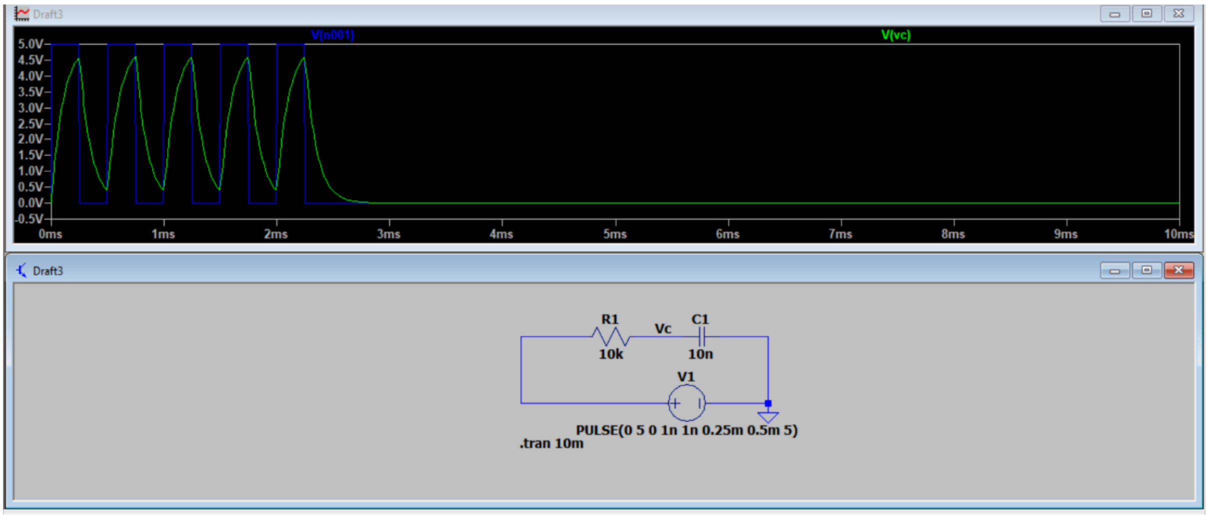
Vpp (output)(experimental)=346mV

Vpp (output)(theoretical)=320mV

Error=-7.52%

Case 4: T==RC for transient condition





In this condition the series RC circuit is not allowed to reach to steady state and the output response is calculated for the transient state condition. To find the output response we display only the first 5 cycles on the oscilloscope, so that steady state has not yet been reached. The LTspice model suggest that during the charging cycle the voltage across capacitor rises exponentially to an intermediate value, and once the charging voltage is switched off the capacitor decays/discharges exponentially to a zero voltage. The cycle continues for the 5 cycles similarly.

We also understand that nowhere during the 5-cycle period will the capacitor reach steady state and we can see

We set up the RC circuit onto the breadboard as done above and set the oscilloscope such only the first 5 initial waveforms are given as input. To do that we conduct the experiment in burst mode and set the #Ncycles to a value of 5.

We set the sweep mode to normal, the trigger input as manual so that we send an input at our will. We also adjust the trigger level optimally so that the output voltages are correctly read by the oscilloscope. We press the single option to send the input wave, then press trigger option to send the wave. Once you see the entire five cycles on your oscilloscope, we stop the waveform so as get the final output on the oscilloscope.

Error:

Vpp (output)(experimental)=3.52V

Vpp (output)(theoretical)=3.89V

Error=9.68%