

Lab Report2

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Objective

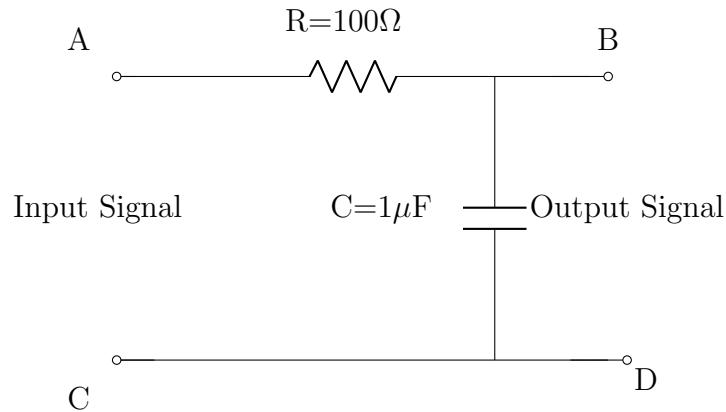
1. Observing the RC response for the square wave input in steady and transient state
 - $RC \ll T$
 - $RC \gg T$
 - $RC \approx T$

Apparatus

- Capacitor($1\mu F$),Resistor($100\ \Omega$),Breadboard
- Cathode Ray Oscilloscope (CRO)
- Signal Generator (1 channel)
- Probes and Connecting Wires

Procedure

1. Form a circuit using the resistor and capacitor in series



1. Connect the signal generator at the input i.e, at A and ground probe at C
2. Connect the probe of CRO at the output i.e, at B and ground probe at D.
3. Adjust the time period and observe the reponse of RC series circuit for different time periods.

Theory

- From kirchhof's circuit law the governing equation is given by,

$$V_{in}(t) = I(t)R + V_c(t) \quad (1)$$

$$I(t) = C \frac{dV_c}{dt} \quad (2)$$

finally,

$$V_{in}(t) = RC \frac{dV_c}{dt} + V_c(t) \quad (3)$$

- We have to the equation (3) in two parts

1. During Charging ($V_{in}(t) = V_{high}$)

- The differential equation becomes:

$$V_{high} = RC \frac{dV_c}{dt} + V_c(t) \quad (4)$$

- Solve using the integrating factor method or by inspection:

$$V_c(t) = V_{final} + (V_{initial} - V_{final})e^{-\frac{t}{\tau}} \quad (5)$$

- $V_{final} = V_{high}$
- $\tau = RC$

2. During Discharging ($V_{in}(t) = V_{low}$)

- The differential equation becomes:

$$V_{low} = RC \frac{dV_c}{dt} + V_c(t) \quad (6)$$

- Solve using the integrating factor method or by inspection:

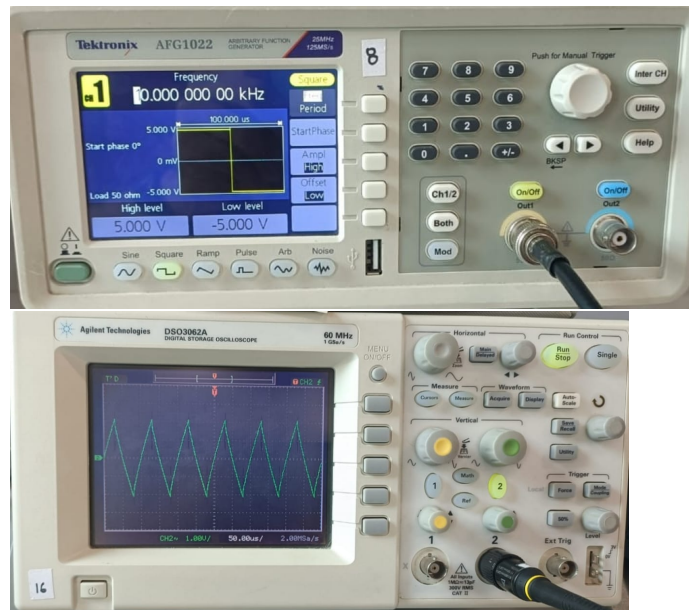
$$V_c(t) = V_{final} + (V_{initial} - V_{final})e^{-\frac{t}{\tau}} \quad (7)$$

- $V_{final} = V_{low}$
- $\tau = RC$

1 Observing RC response in steady state

1.1 When $\tau=T$

- Figures

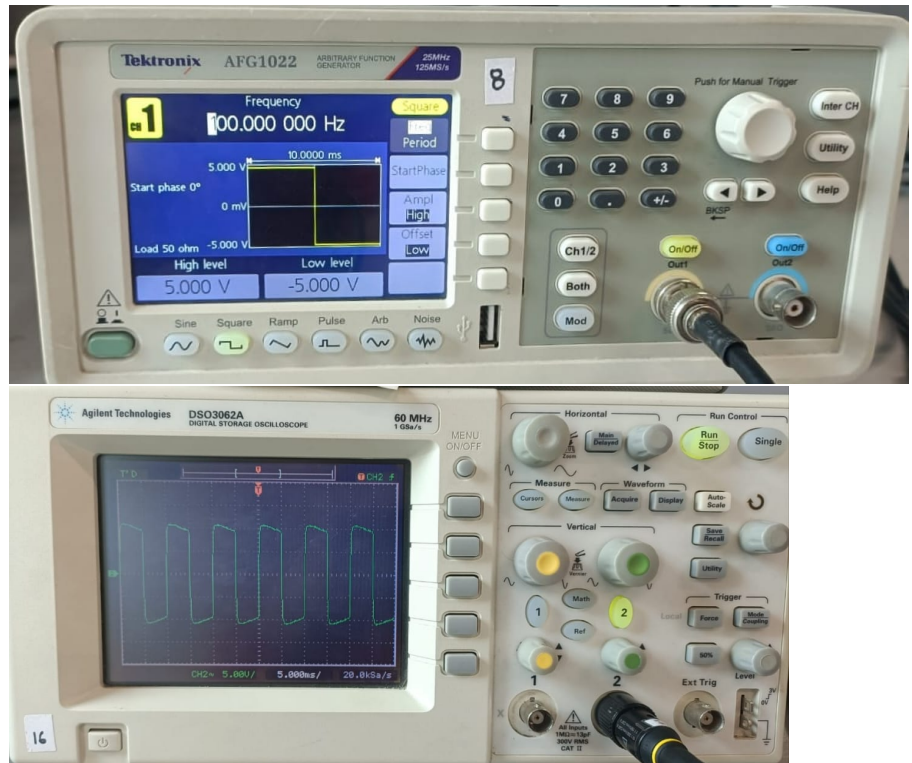


- Observation

- The capacitor never charges or discharges completely. it just exponentially charges and discharges in every half cycle
- It never reaches the V_{high} or V_{low}
- The capacitor voltage will appear as a smoothed waveform, lagging behind the input and transitioning exponentially.

1.2 When $RC \ll T$

- Figures

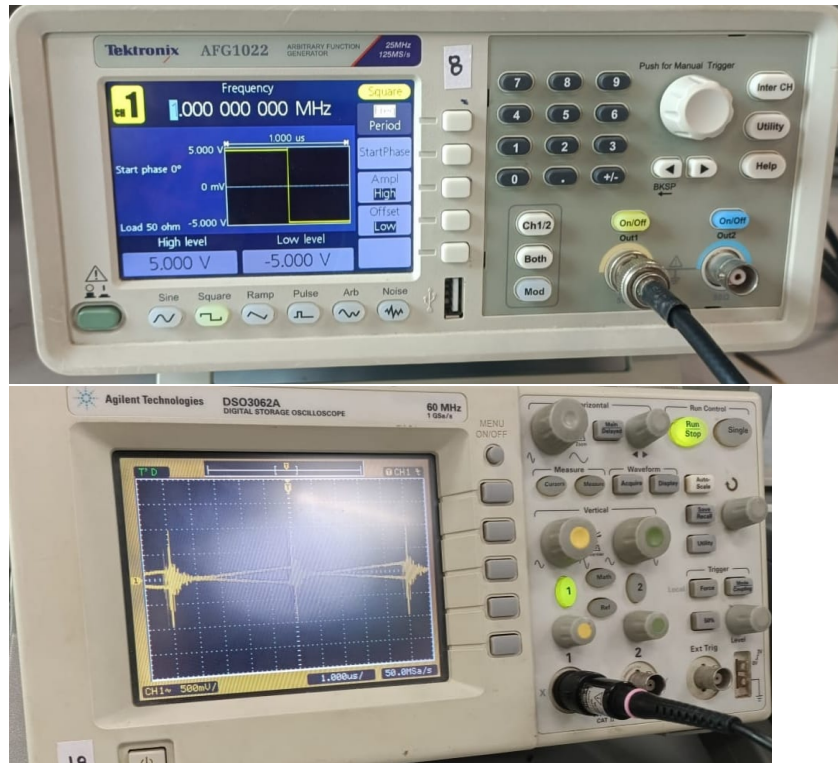


- Observation

- The capacitor gets fully charged and fully discharged in each cycle as $RC \ll T$
- It almost follows the square wave form

1.3 When $RC \gg T$

- Figures



- Observation

- The capacitor in the circuit acts as a low-pass filter.
- The capacitor is not able to pick up with the rapid change between $+V$ and $-V$ of the square wave.

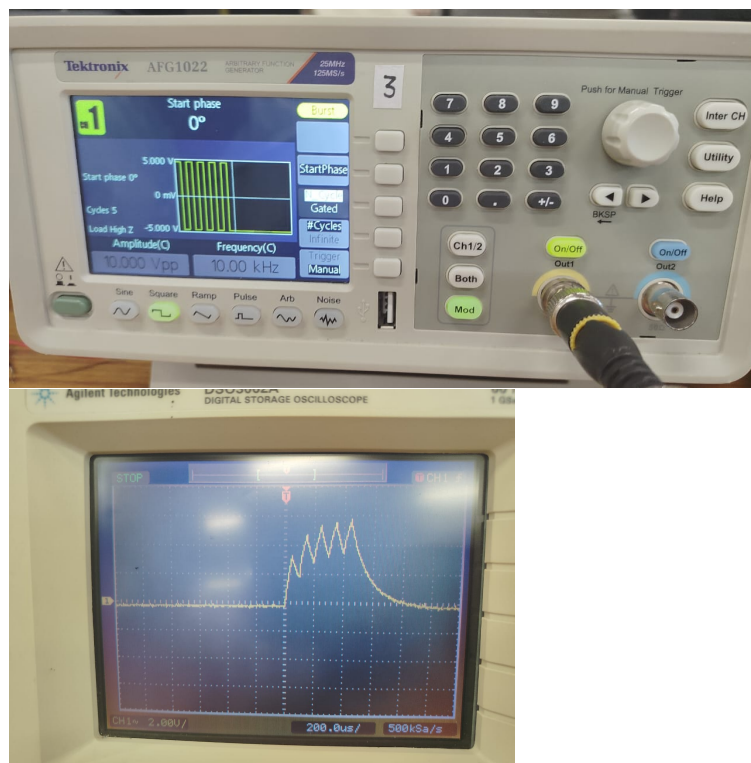
2 Observing RC response in transition state

Procedure

- Same as previously described but now we will pass only for 5 time periods from function generator
- We have set the CRO to one time event capture mode

2.1 When $\tau = T$

- Figures



- **Observation**

- The capacitor never charges or discharges completely. it just exponentially charges and discharges in every half cycle
- initially it charges and in the second half it discharges but not completely
- and the cycle goes on continuing untill steady state

2.2 When $RC \ll T$

- Figures

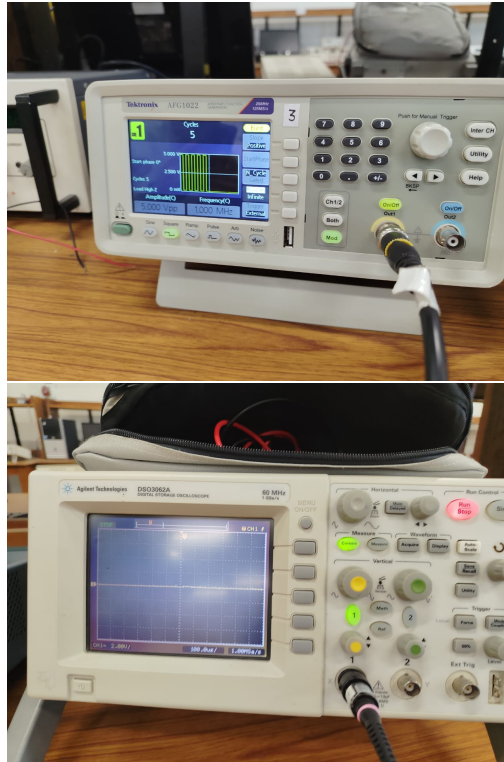


- Observation

- The capacitor gets fully charged and fully discharged in each cycle as $RC \ll T$
- It almost follows the square wave form

2.3 When $RC \gg T$

- Figures



- Observation

- Initially the capacitor is not able to pick up with change in square waveform
- neither it get charged nor discharged hence it appears to be flat