Lab Report2

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Objective

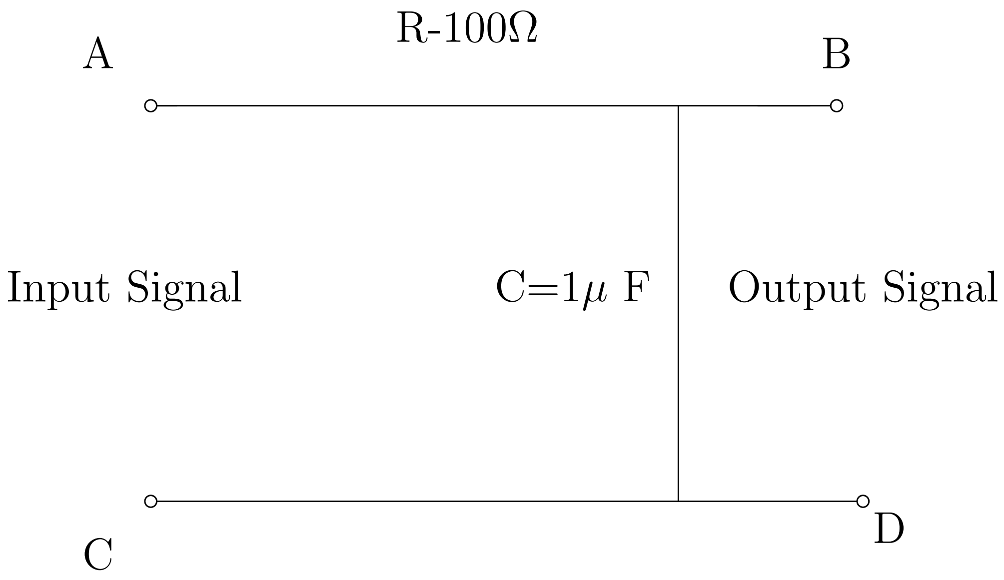
1. Observing the RC response for the square wave input in steady and transient state
    - RC==T
    - RC>>T
    - RC<<T

Apparatus

- Capacitor($1\mu F$),Resistor(100 Ω),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



2. Connect the signal generator at the input i.e, at A and ground probe at C
3. Connect the probe of CRO at the output i.e, at B and ground probe at D.
4. 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,

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

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

finally,

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

- We have to the equation (**??**) in two parts
    1. During Charging ($V_{in}(t) = V_{high}$)

        - The differential equation becomes:

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

        - Solve using the integrating factor method or by inspection:

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

        - $V_{final} = V_{high}$
        - τ=RC
    2. During Discharging ($V_{in}(t) = V_{low}$)

        - The differential equation becomes:

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

        - Solve using the integrating factor method or by inspection:

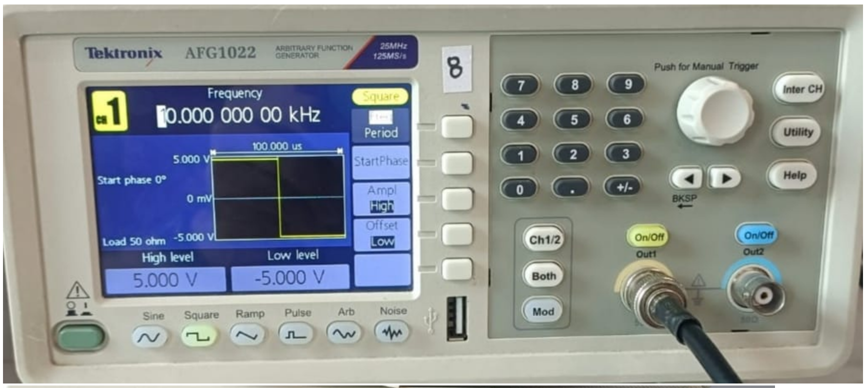
        $$V_c(t) = V_{final} + (V_{initial} - V_{final})e^{-\frac{t}{\tau}} \tag{7}$$

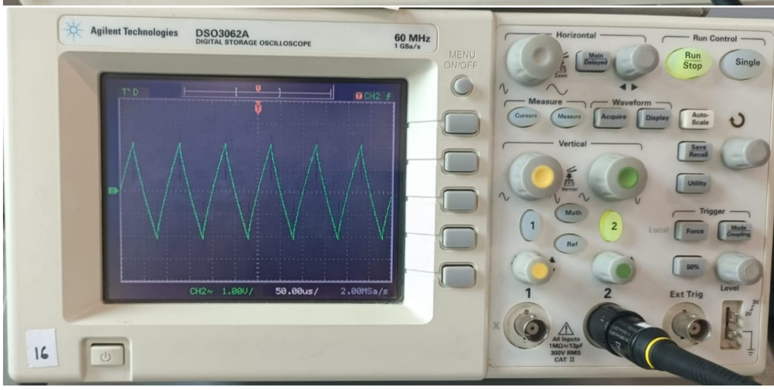
        - $V_{final} = V_{low}$
        - τ=RC

1 Observing RC response in steady state

1.1 When τ=T

- **Figures**



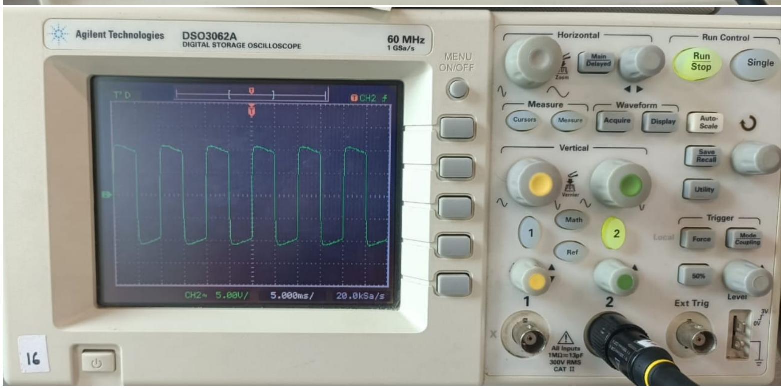


- **Observation**

  - 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**

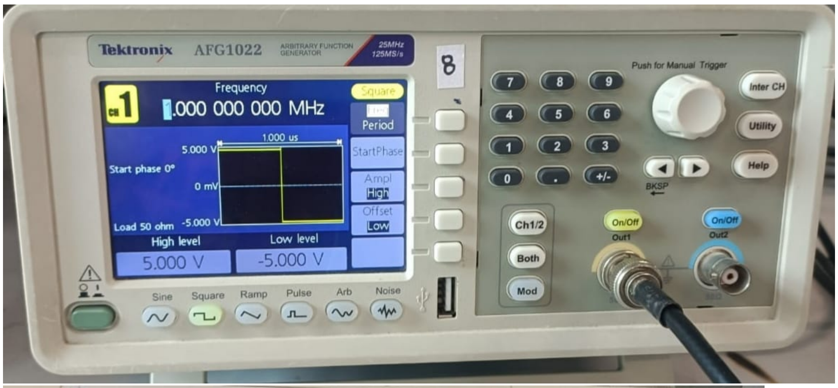


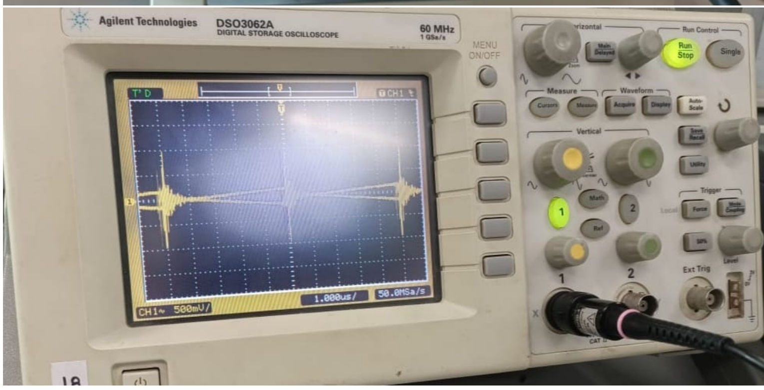
- **Observation**

  - 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.

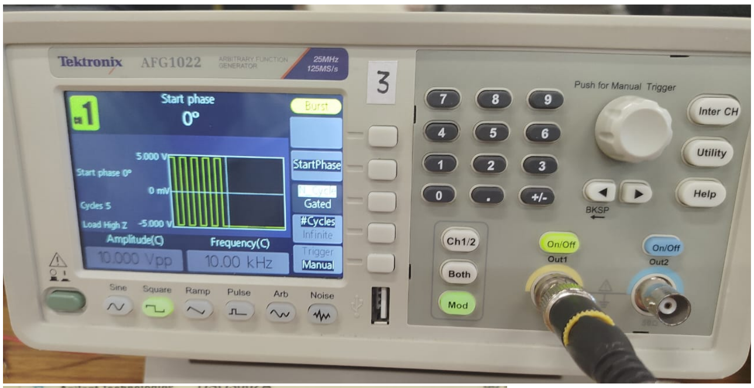
2 Observing RC response in transition state

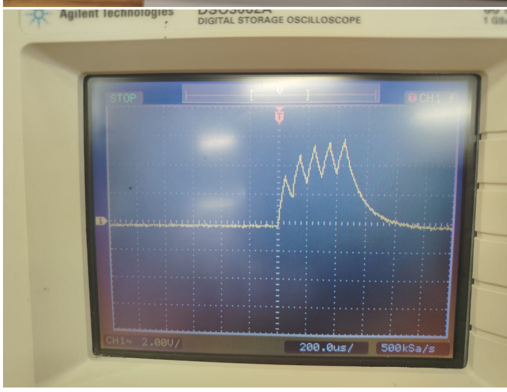
Procedure

- 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 τ=T

- **Figures**



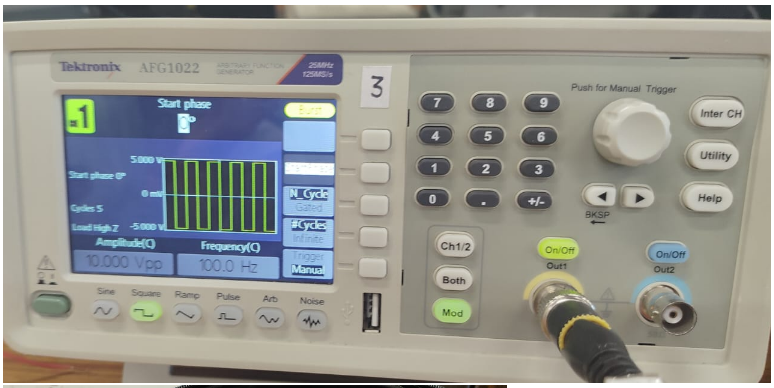


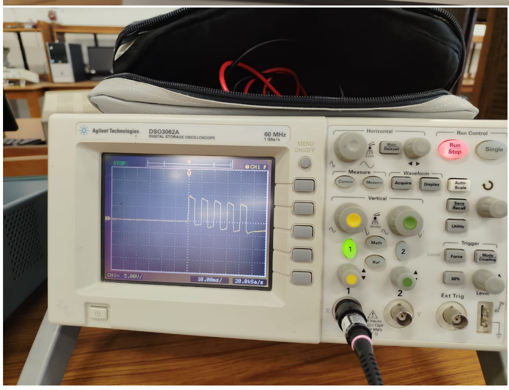
- **Observation**

  - 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 compltely
  - and the cycle goes on continuing untill steady state

2.2 When $RC \ll T$

- **Figures**



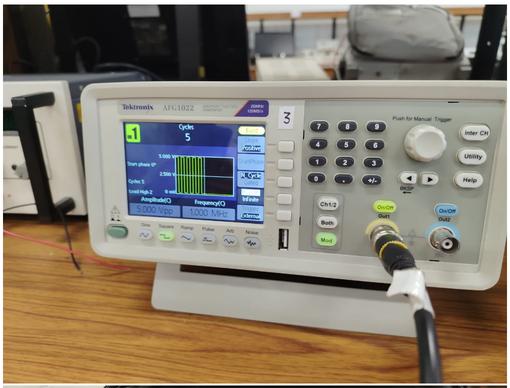


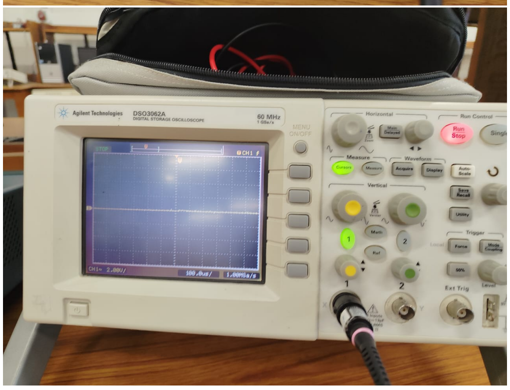
- **Observation**

  - 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
  - niether it get charged nor discharged hence it appeare to be flat

Thank You