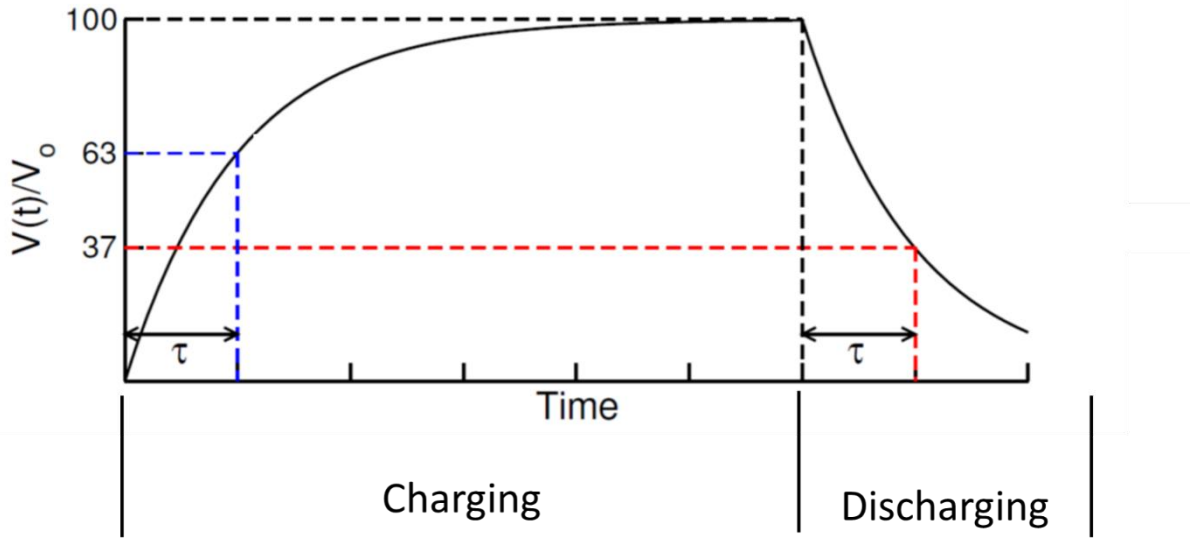
Measuring the time constant of an RC circuit using a digital Oscilloscope:

Objective:

The main objective of this lab is to understand the basic characteristics of an RC circuit and measure the time constant of an RC circuit.

Theory:

Time constant of an RC circuit can be measured in two different ways using a digital oscilloscope. The charging and the discharging curves of an RC circuit are shown is shown in the following figure. The time constant theoretically given by τ = RC, is the time taken by the circuit to charge the capacitor from 0 to 0.632 times of the maximum voltage. This can be derived from the charging equation of an RC circuit given in equation 1.



$$V(t) = V_o\left(1 - e^{-t/\tau}\right) \quad (1)$$

$$V(t) = V_o e^{-t/\tau} \quad (2)$$

In case of discharging, the time constant is the amount of time required to reduce the voltage across the capacitor from the maximum value to 0.368 of the maximum value. This relation can be derived from equation 2 by replacing t by τ.

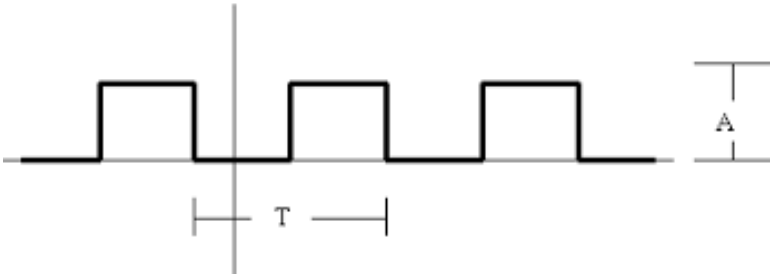
Apparatus:

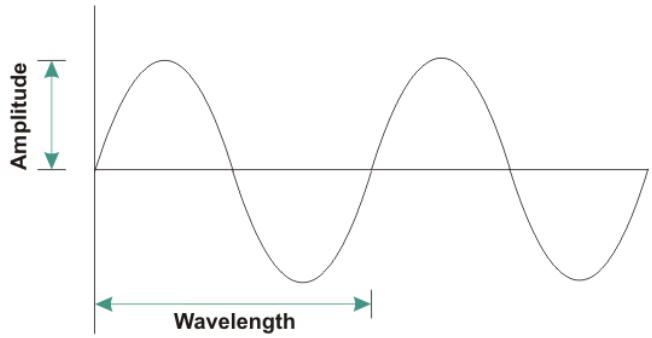
Resistor close to 500 Ω, capacitor close to 30 μF, digital oscilloscope, circuit board, function generator, connecting wires and oscilloscope probes.

Procedures:

Warm up

1. Get a function generator and connect its output to the oscilloscope and display the output as sinusoidal wave, square wave and triangular wave. Set the frequency at 100Hz and the amplitude at 5V. Get snapshot of each wave and attach them with your report.



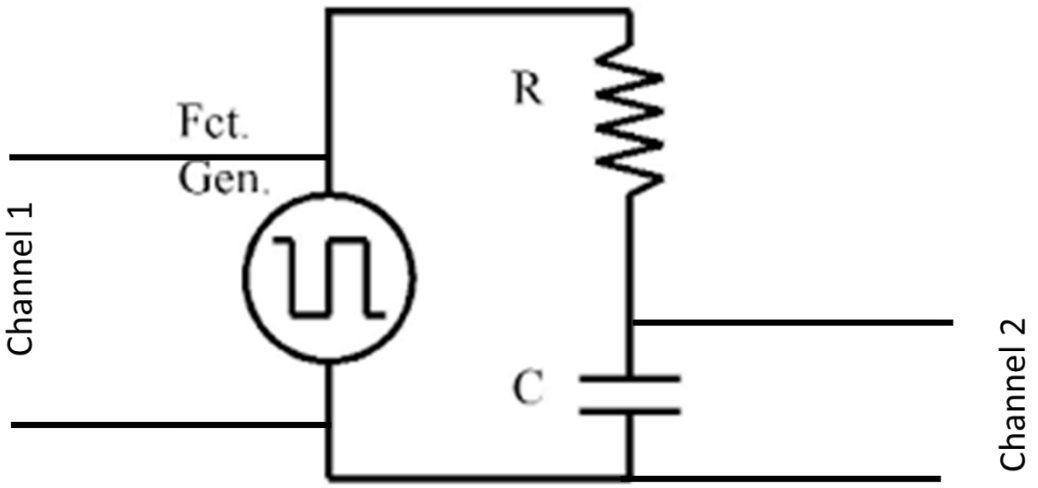


N = 0

2. Practice to change the frequency and the amplitude of the generator output. Learn to measure them from the oscilloscope. Get help from the instructor.
3. Make sure you are doing it correctly. Get help from the instructor.

RC Circuit:

Complete the RC circuit on the circuit board as shown in the following figure. Get help from the instructor if required.



Connect the function generator output to channel 1 using a BNC Tee and the voltage across the capacitor to channel 2. Set the output of the generator amplitude at 5V and the frequency at 60HZ.

Show your oscilloscope display to the instructor to make sure it is correct. Measure the time constant from the charging and discharging curves. To measure the time constant precisely make sure the corresponding curves fully cover the display screen as shown below.

Once the time constant is measured from both curves, next overlay the channel 1 and channel 2 curves on top of each other and take a snapshot. This snapshot also should go on your report.

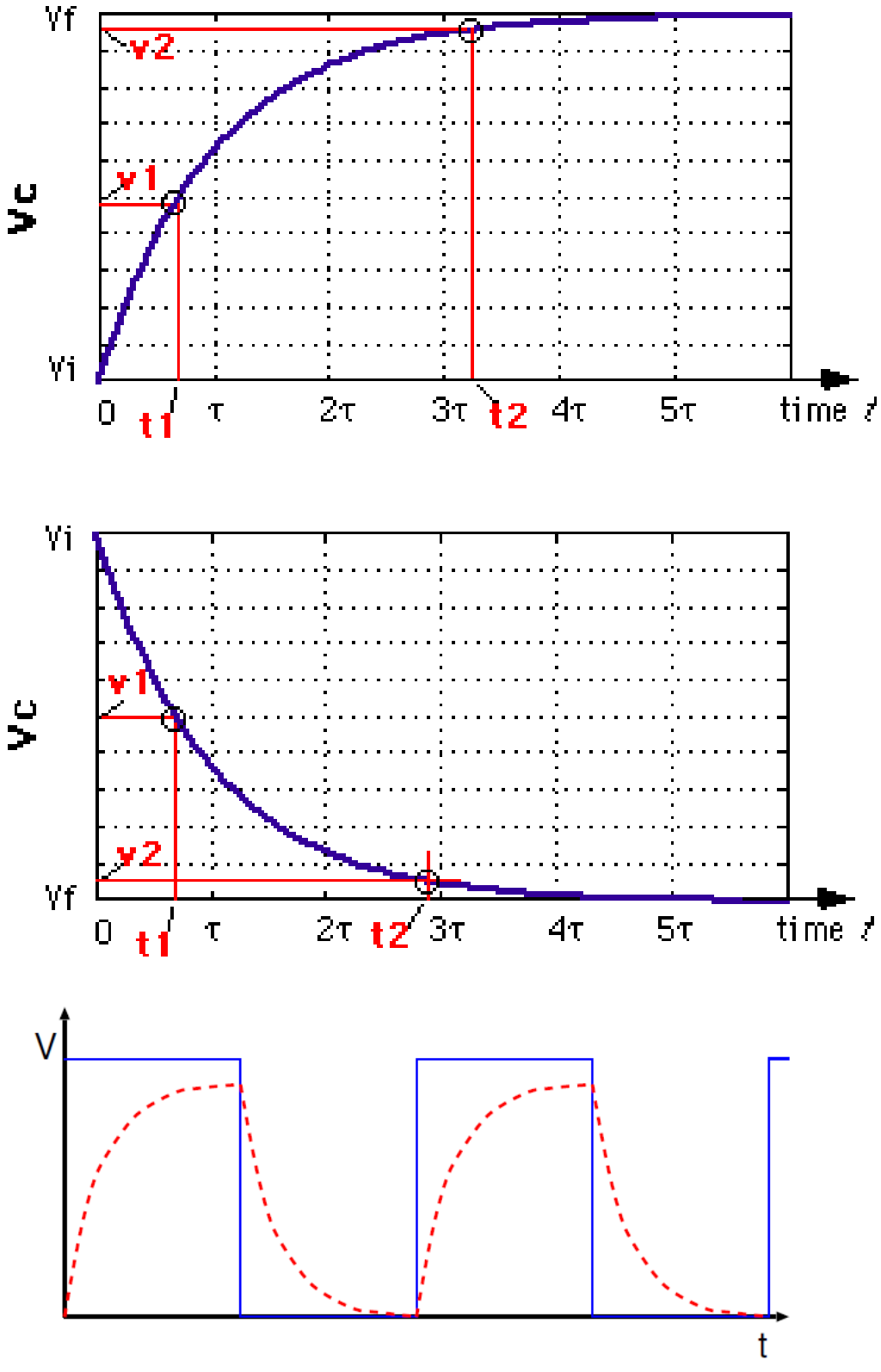


Figure 1: Overlay of Channel 1 and Channel 2

Observations and Analysis:

Measured value of R = ……Ohm

Measured Capacitance = Farad

Predicted Time constant = S

Measured time constant 1 = …..S

Measured Time constant 2 =……..S

Measured time constant = Average of 1 and 2

Percentage difference between measured and predicted =

Discuss the charging and discharging of the capacitor on the basis of Figure 1.

Questions

As you know $\tau = RC$ is the time constant in an RC circuit. Using the equations in 1 or 2 find out expressions for the times required to charge from to half of the maximum voltage or to discharge from maximum voltage to the half voltage.