BRAC UNIVERSITY
DEPT. OF COMPUTER SCIENCE AND ENGINEERING
COURSE NO.: CSE250
Circuits and Electronics Laboratory

EXPT. NO.7

Name of the Experiment:

STUDY OF TRANSIENT BEHAVIOR OF RC CIRCUIT

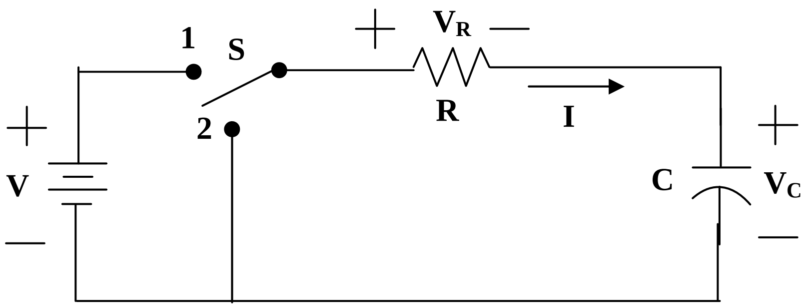
OBJECTIVE:

The objective of this experiment is to study Transient Response of RC circuit with step Input. In this experiment we shall apply a square wave input to an RC circuit separately and observe the respective wave-shapes and determine the time constants.

THEORY:

The transient response is the temporary response that results from a switching operation and disappears with time. The steady state response is that which exists after a long time following any switching operation.

Let us consider an RC circuit shown in figure.



CHARGING PHASE:

When the switch is connected to position 1, applying KVL we can write

$$V = Ri + \frac{1}{C}\int i\,dt \text{ ------------ } (1)$$

If the capacitor is initially uncharged, the solution of equation (1) is----

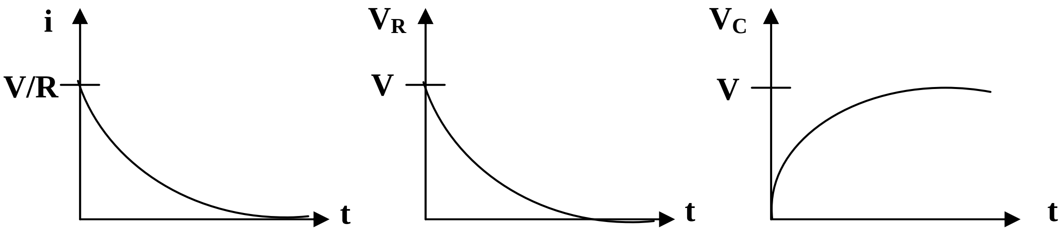
$$i = \frac{V}{R} e^{-\frac{t}{\tau}} \text{ ---------------- } (2)$$

Therefore the voltage across the resistor and capacitor are given by

$$V_R = Ve^{-\frac{t}{\tau}} \text{ --------------- } (3)$$

$$V_C = V - V_R = V(1 - e^{-\frac{t}{\tau}}) \text{ ------ } (4)$$

Where τ = RC and is called the time constant of the circuit.
Equation (2), (3) & (4) are plotted below:



It is seen from the curves that the voltage across the capacitor rises from zero to V volts exponentially and the charging current is maximum at the start i.e. when C is uncharged, then it decreases exponentially and finally ceases to zero when the capacitor voltage becomes V.

DISCHARGING PHASE:

When the switch is connected to position 2, applying KVL we can write

$$0 = Ri + \frac{1}{C}\int idt -------------(5)$$

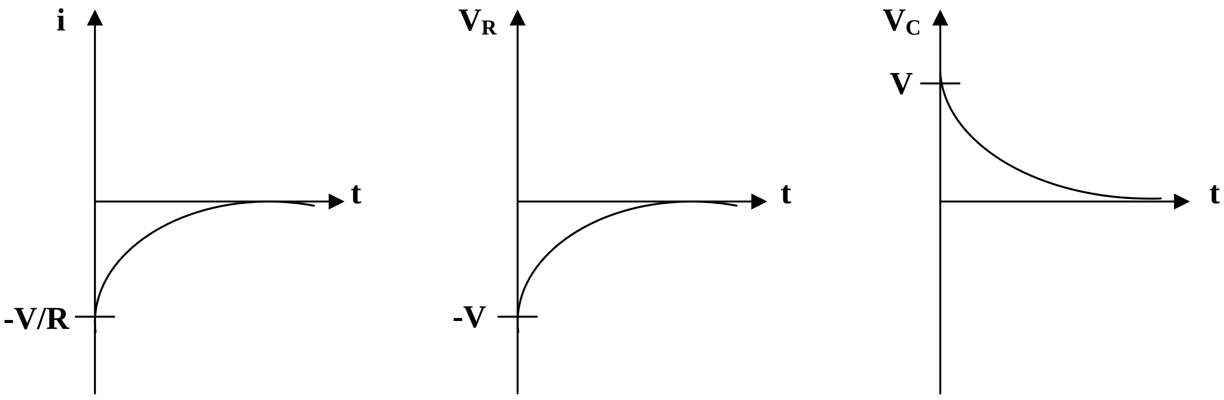
Since the voltage across the capacitor is now V, the solution of equation (5) is
Therefore the voltage across the resistor and capacitor are given by

$$i = -\frac{V}{R}e^{-\frac{t}{\tau}} --------------(6)$$

$$V_R = -Ve^{-\frac{t}{\tau}} --------------(7)$$

$$V_C = Ve^{-\frac{t}{\tau}} ---------------(8)$$

Equation (6), (7) & (8) are plotted below:



It is seen from the curves that the voltage across the capacitor falls from V to zero volts exponentially. The charging current is maximum at the start i.e. when the switch is just thrown to position 2, then it decreases exponentially and finally ceases to zero when the capacitor voltage becomes zero.

APPARATUS:

- Resistance: 1KΩ
- Capacitance: 1μF
- Oscilloscope and Chords
- Signal Generator and Chords
- Wires
- Bread board

EXPERIMENTAL SETUP:

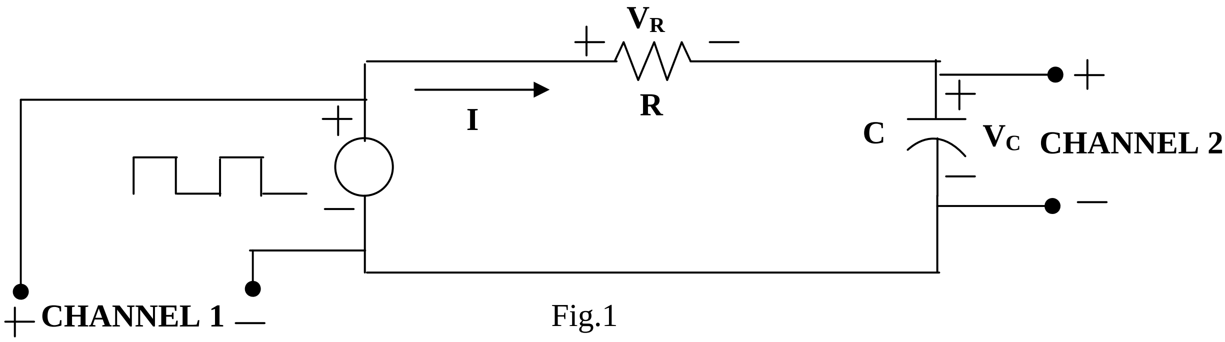


Fig.1

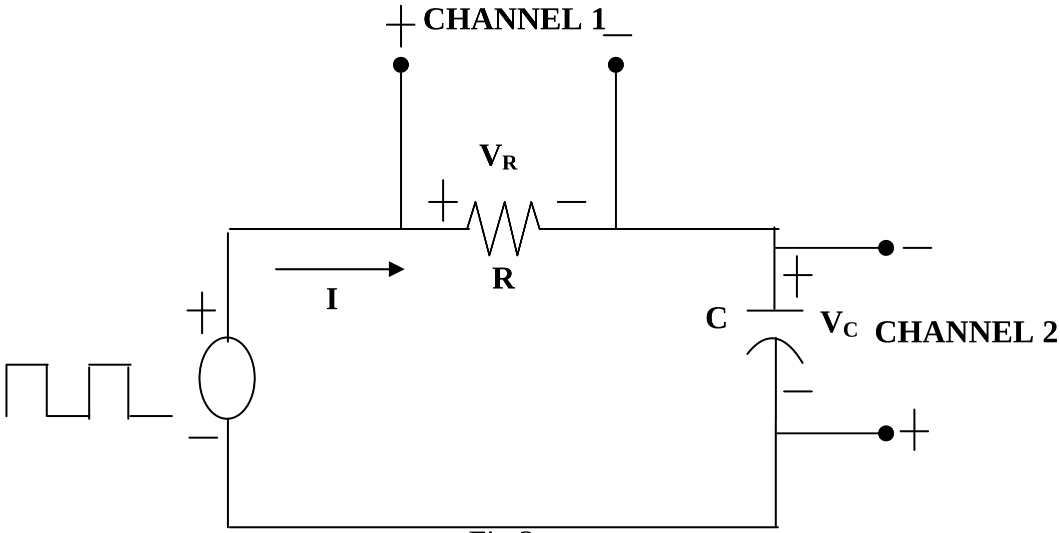


Fig.2

PROCEDURE:

1. Setup the circuit as shown in figure 1.
2. Apply 100Hz square wave from signal generator.
3. Observe the wave shapes at Ch.1 and Ch.2 in DUAL mode and draw them. Find the time constant from the wave shape of V_C.
4. Disconnect Ch.1 and Ch.2 and reconnect them as shown in figure 2.
5. Observe the wave shapes at Ch.1 and Ch.2 (INV.) in DUAL mode and draw them.

REPORT:

1. Draw all the wave shapes on graph

QUESTION:

1. Define capacitor and capacitance. Write the features of a capacitor. What does capacitance measure?
2. Deduce voltage-current relationship for a capacitor. Why the voltage across a capacitor cannot change instantaneously.
3. Define time constant for an RC circuit. What is the significance of time constant? How time constant can be determined?
4. Describe the charging and discharging phase of an RC circuit both qualitatively and quantitatively.

REFERENCE BOOKS:

- Introduction to Electric Circuits.
  By R.C. Dorf & J.A. Svoboda.
- Introductory Circuit Analysis.
  By R. L. Boylestad.
- A Text book of Electrical Technology, Vol. 1
  By B.L Theraja & A.K. Theraja