Lab 3

Step Response Of RC Circuit

Step Response: *When something changes in a circuit, like a switch closes, the voltages and currents in the circuit elements adjust to the new conditions. If the change is an abrupt step, the response of the voltages and currents is called the step response.*

Motivation: The complete response of RC and RLC circuits to step inputs involves the determination of the transient and steady-state solutions of the circuit. Since the energy storage elements such as inductors or capacitors do not permit an instantaneous change in the energy, the transient part of the solution makes a smooth transition from one energy level to another. Thus a gradual change takes place from some initial level till the new steady-state level is reached. Sudden loading of a generator or a beam in a structure, sudden change in the setting of a value, or failure of a hydraulic pump involves response due to the step input. Step function apart from being mathematically simple to analyze represents a rather severe type of the disturbance appearing in the system. Moreover, an arbitrary function can be approximated in the form of a series of step input facilitates the finding of the response to any arbitrary input. The dynamic characteristics of simple systems can be described by first order (RC circuit) or second order (RLC circuit) differential equations. The complete response is then identified in two parts - complementary function (transient solution) and particular integral (steady-state solution). It is always possible to obtain the complete response of complicated systems such as linear combination of first and second order systems. Although attention here is confined to electrical circuits, the same basic model can be used to represent a wide range of mechanical, pneumatic or chemical systems.

Objectives:

1. Observe the step response of RC circuit and calculate the time constant from the waveform.
2. To observe and trace the complete response to step input.
3. To determine the time constant and check with the theoretically calculated value.

1. Simulation Procedure for step response of RC circuit;

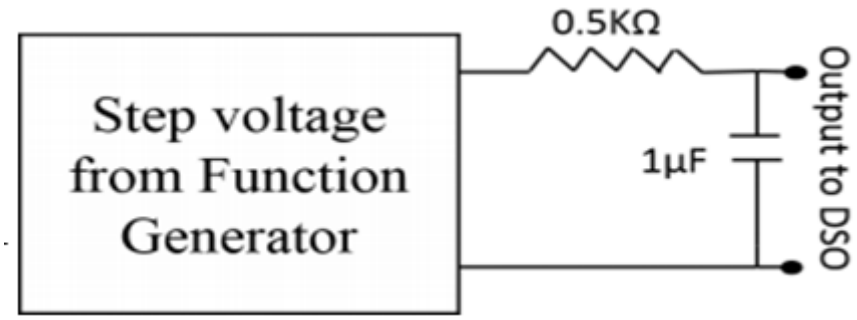

Fig.1

1. Draw circuit as shown in Fig. 1 on LTspice schematic window. Set C= 1uF and R = 0.5k

2. Now you need to generate a step voltage. For that, apply source voltage as you did in earlier labs. Right-click to set the value and click on Advanced. Select pulse function with Vinitial=0, Von=5 V, Tdelay=0, Trise=0, Tfall=0, Ton=10, Tperiod=0, Ncycles=0 (or just set Von=5 & Ton=10, other entries will automatically be 0).
3. Simulate and plot the waveform of voltage across the capacitor.
4. Note the value of the voltage at t=RC.
5. Observe the waveform for 2 different combinations of R(1K,10K) and C(0.1μF, 10μF).

2. Hardware Implementation:

Draw the same circuit as done on LTSpice and repeat all steps. Note down the practical values. Use DSO for generating the pulse signal (DSO built-in waveform generator) and observing the output (any channel out of 2 available channels).

3. Observation Table:

S.No	R	C	V_c (Theoretical)	V_c (LTSpice)	V_c (Breadboard)
1	500Ω	1μF			
2	1kΩ	0.1μF			
3	10kΩ	10μF			

Deliverables:

When coming to the lab:

- Check the file format & grading rubrics (already posted on the classroom (BE Lab Flow).
- Submit the LTSpice file (.asc) of this experiment to the classroom (individual task).
- Keep the theoretical & LTSpice results of this experiment with you on a rough copy.
- Submit the practical file with completed experiment-2 and index on entering the lab.