EXPERIMENT 5
FIRST-ORDER CIRCUITS

5.1 Objective:

In this experiment, you will learn the square wave response of RC circuits.

- **i.** Experimental observation of the first-order circuit characteristics for capacitive circuits.
- **ii.** Evaluation and observation of time constant experimentally.

5.2 Equipment List:

- DSO, CADET,
- Function Generator,
- Capacitors (10nF, 4.7 nF, 47 nF),
- Resistors (33 kΩ, 100 kΩ).

5.3 Preliminary Work:

1. Consider the circuit in Figure 1b and the input voltage waveform $V_{in}(t)$ given in Figure 1c and take V_1=1V, V_2=3V, T=100μs (or f=10kHz), R=500Ω, L=4.0mH, and R_L=0Ω.

- **i.** Obtain the differential equation and, for the given values, determine and sketch $V_R(t)$ and $V_L(t)$.
- **ii.** Calculate the time constant τ.

2. Consider the circuit in Figure 1b and the input voltage waveform $V_{in}(t)$ given in Figure 1c and take V_1=1V, and V_2=3V.

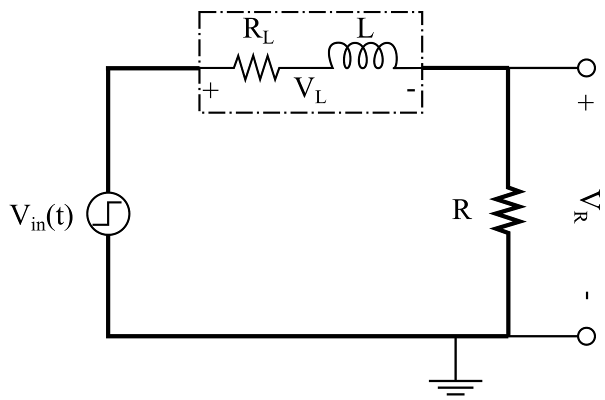


Figure 1.a

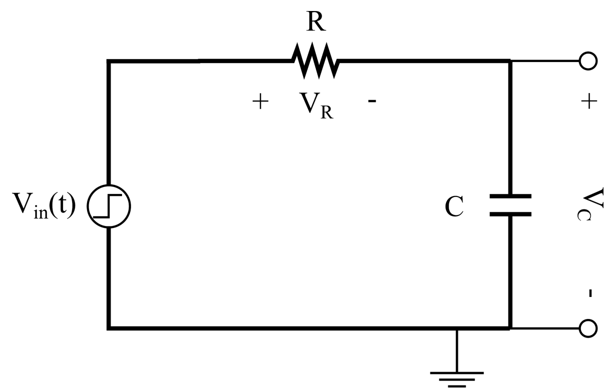


Figure 1.b

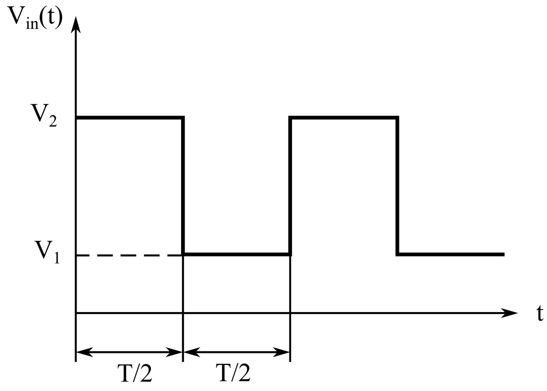


Figure 1.c

i. Obtain the differential equation and, for the given values of "f, R, and C" in Table 1, determine and sketch $V_R(t)$ and $V_C(t)$.

	f (kHz)	R (kΩ)	C (nF)
Case 1	2	3.3	4.7
Case 2	2	3.3	10
Case 3	2	68	10

Table 1

ii. Calculate the time constant τ in each case.

5.4 Experimental Work:

Important: Show a sample of the measurement in each work to the conducting research assistant for RA signature.

1. Adjust the square wave output of the function generator (use TTL oscillator towards left and bottom of CADET and the ground connection in the symmetric 5V) where f=100Hz.

i. Adjust the square wave output of the function generator where f=100Hz.

ii. Set up the circuit of Figure 1a for the values of f, R, and C given in the Report Sheet.

iii. Observe the voltage waveforms $V_{in}(t)$, and $V_C(t)$ by making necessary probe connections. Set the relevant oscilloscope configurations to show the one cycle of the voltage waveforms $V_{in}(t)$ and $V_R(t)$, and $V_C(t)$ and plot the waveforms separately. You need to use MATH mode in the oscilloscope to get $V_R(t)$ by subtracting the channel for $V_{in}(t)$ from the channel for $V_C(t)$.

iv. Considering that the function generator is grounded output at the given frequencies, determine the time constants τ of the circuits experimentally. Show how you find the value in the $V_C(t)$ plot.

v. Compare your results with your calculations.

2. Explain how the time constant changes with the passive circuit elements.

EXPERIMENT 5
REPORT SHEET

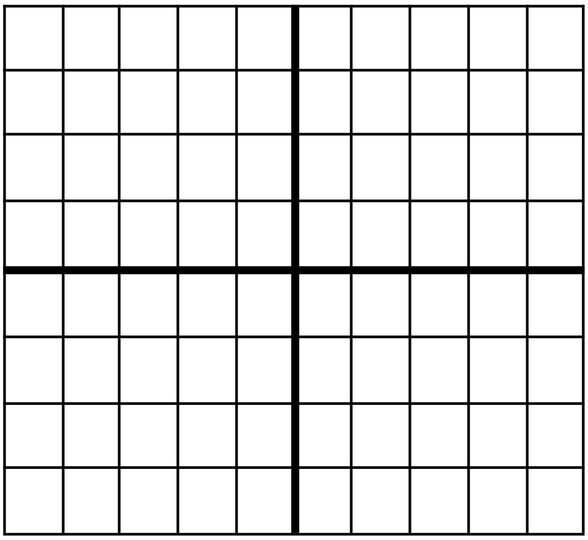
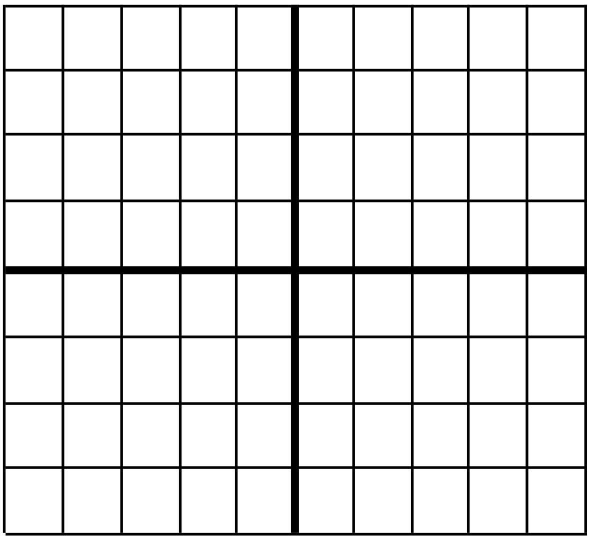
Name & Surname :

Date :

Experimental Work :

1.

f = 100 Hz, R = 33 kΩ, C = 4.7 nF	f = 100 Hz, R = 33 kΩ, C = 10 nF
$V_{in}(t)$	**$V_{in}(t)$**
$V_R(t)$	**$V_R(t)$**

f = 100 Hz, R = 33 kΩ, C = 4.7 nF	f = 100 Hz, R = 33 kΩ, C = 10 nF
V_C(t) 	**V_C(t)** 
Time Constant τ:	Time Constant τ:
DSO Settings **VOLTS/DIV:** **TIME/DIV :**	**DSO Settings** **VOLTS/DIV:** **TIME/DIV :**

f = 100 Hz, R = 33 kΩ, C = 47 nF	f = 100 Hz, R = 100 kΩ, C = 47 nF
$V_{in}(t)$	**$V_{in}(t)$**
$V_R(t)$	**$V_R(t)$**

f = 100 Hz, R = 33 kΩ, C = 47 nF	f = 100 Hz, R = 100 kΩ, C = 47 nF
$V_C(t)$	**$V_C(t)$**
Time Constant τ:	Time Constant τ:
DSO Settings **VOLTS/DIV:** **TIME/DIV :**	**DSO Settings** **VOLTS/DIV:** **TIME/DIV :**

RA Signature:

2. Explain how the time constant changes with the passive circuit elements.

3. Conclusion: