# EXPERIMENT 5 – ONLINE VERSION FIRST ORDER CIRCUITS

## 5.1 Objective:

In this experiment, you will learn the square wave response of RC and RL circuits are studied.

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

## 5.2 Equipment List:

**Simulation Software:**

* LTspice

**In laboratory Session:**

* DSO, CADET,
* Function Generator,
* Inductor (3.9 mH)
* Capacitors (10nF, 4.7 nF, 47 nF),
* Resistors (500Ω, 3.3 kΩ, 33 kΩ, 100 kΩ).

## 5.3 Preliminary Work:

**1**. Consider the circuit in Figure 1.a and the input voltage waveform Vin(t) given in Figure 1.c and take V1=0V, V2=5V, T=100μs (or f=10kHz), R=500Ω, L=3.9mH, and RL=0Ω.

**i.** Obtain the differential equation and, for the given values, determine and sketch VR(t) and VL(t).

**ii.** Calculate the time constant τ.

**2.** Consider the circuit in Figure 1.b and the input voltage waveform Vin(t) given in Figure 1.c and take V1=0V, and V2=5V.

|  |  |
| --- | --- |
| **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 VR(t) and VC(t).

|  |  |  |  |
| --- | --- | --- | --- |
|  | f (Hz) | R (kΩ) | C (nF) |
| Case 1 | 100 | 3.3 | 4.7 |
| Case 2 | 100 | 33 | 10 |
| Case 3 | 100 | 33 | 47 |
| Case 4 | 100 | 100 | 47 |

**Table 1**

**ii.**  Calculate the time constant τ in each case.   
  
**3.** How can τ be found experimentally from the voltage waveforms VR(t) in (**1**), Vc(t) in (**2**) on DSO screen? **Hint:** Consider the exponential characteristics of voltage waveforms in one interval.

## **5.4 Experimental Work**:

**1.** Taking Figure 1.c into account, generate and plot the following square wave signals listed in Table 2 in LTspice. Observe and verify the period of each waveform.

|  |  |  |  |
| --- | --- | --- | --- |
|  | V1 (V) | V2 (V) | f (kHz) |
| Signal 1 | 0 | 5 | 1 |
| Signal 2 | 0 | 3 | 25 |
| Signal 3 | 0 | 8 | 50 |

**Table 2**

**2.** Set up the circuit in Figure 1a, where R=500Ω, L=3.9mH, and RL=0Ω. Adjust Vin(t)to a square wave signal with V1=0V, V2=5V and f=10kHz.

**i.** Observe the voltage waveforms Vin(t), VR(t) by making necessary probe connections. Set the relevant scope configurations to show the one cycle of the voltage waveforms Vin(t) and VR(t) in dual mode and plot the waveforms.

**ii.** Determine the time constant τ of the circuit experimentally. Show how you find the value in the plot.

**iii.** Compare your results with your calculations**.**

**3.** Set up the circuit in Figure 1.b with the given R and C values in the report sheet. Adjust Vin(t) to a square wave signal with V1=0V, V2=5V and f=100Hz.

**i.** Observe the voltage waveforms Vin(t), VC(t) by making necessary probe connections. Set the relevant scope configurations to show the one cycle of the voltage waveforms Vin(t) and VR(t), and VC(t). Plot the waveforms.

**ii.** Determine the time constants τ of the circuits experimentally. Show how you find the value in the VC(t) plot.

**iii.** Compare your results with your calculations.

# EXPERIMENT 5 REPORT SHEET

**Name :** **Date :**

**Experimental Work :**

**Note : For each part, first, provide the LTspice circuit schematic and then corresponding scope output right below the schematic. Explain the figures with informative captions.**

**1.** Provide the image of the schematic and plot all the signals in a single scope output. Comment on differences.

|  |
| --- |
| **Insert the Schematic Here** |
| **Figure 1:** Add the caption |

|  |
| --- |
| **Insert the Scope Output Here** |
| **Figure 2:** Add the caption |

**Comments:**

**2.** Provide the image of the schematic and plot the signals in a single scope output. Determine the time constant τ and briefly explain how you find it.

|  |
| --- |
| **Insert the Schematic Here** |
| **Figure 3:** Add the caption |

|  |
| --- |
| **Insert the Scope Output Here** |
| **Figure 4:** Add the caption |

**Time constant τ:**

**Comments:**

**3.** Provide the image of the schematic and plot Vin(t) and VR(t) in a single scope output. Also, plot VC(t) in a different scope output. Determine the time constant τ and briefly explain how you find it. Perform these steps for each case. Comment on your findings.

|  |
| --- |
| **Insert the Schematic Here** |
| **Figure 5:** Add the caption |

**Case 1:** f=100Hz, R=3.3kΩ, C = 4.7 nF

|  |
| --- |
| **Insert the Scope Output for Vin(t) and VR(t) Here** |
| **Figure 6:** Add the caption |

|  |
| --- |
| **Insert the Scope Output for VC(t) Here** |
| **Figure 7:** Add the caption |

**Time constant τ:**

**Case 2:** f=100Hz, R=33kΩ, C = 10 nF

|  |
| --- |
| **Insert the Scope Output for Vin(t) and VR(t) Here** |
| **Figure 8:** Add the caption |

|  |
| --- |
| **Insert the Scope Output for VC(t) Here** |
| **Figure 9:** Add the caption |

**Time constant τ:**

**Case 3:** f=100Hz, R=33kΩ, C = 47 nF

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| --- |
| **Insert the Scope Output for Vin(t) and VR(t) Here** |
| **Figure 10:** Add the caption |

|  |
| --- |
| **Insert the Scope Output for VC(t) Here** |
| **Figure 11:** Add the caption |

**Time constant τ:**

**Case 4:** f=100Hz, R=100kΩ, C = 47 nF

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| --- |
| **Insert the Scope Output for Vin(t) and VR(t) Here** |
| **Figure 12:** Add the caption |

|  |
| --- |
| **Insert the Scope Output for VC(t) Here** |
| **Figure 13:** Add the caption |

**Time constant τ:**

**Comments:**

**4. Conclusions:**

**i.** Briefly explain how the time constant changes with the passive circuit elements.