**Lab 4 : Studying DC transients and AC Signals**(eLearning Week - Simulation and Analysis Lab)

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| **Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  **Matric. No.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  **Day / Table No.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | |  |  | | --- | --- | | **Activities Completed** | **Marks From** 2 | | **1A** |  | | **1B** | | **2A** | | **2B** | |

1. **Objectives of the Simulation**
2. To learn about the behaviour of RC and RL circuits under DC transient and AC steady-state operation.
3. To be able to measure the time constants for RC, RL circuits using cursors.
4. To be able to measure phase differences in AC circuits using cursors.
5. **Components**

* Voltage Source
* Resistors
* Capacitors
* Inductors

1. **Simulation Tasks**
2. **DC Transients**
3. [30%, 60mins]



What is the formula for the Time Constant of a RC circuit?

****** *= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

Choose the values of R and C to obtain a time constant of ( **Last two Digits of Matriculation Number + 5 ) \* 10)** us. Available component values can be found in “DSA Component List” in IVLE’s Lab folder.

***R*** *= \_\_\_\_\_\_\_\_\_* ***C*** *= \_\_\_\_\_\_\_\_\_  = \_\_\_\_\_\_\_\_\_\_\_\_\_*

With the calculated time constant above, calculate the amount of time required for to reach approximately 99% of steady-state value.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Choose a period for that will allow to fully charge up. The signal of is shown as below. Draw the expected signal on the waveform below.

*, Period of = \_\_\_\_\_\_\_\_\_\_\_\_\_*

1. Set up the circuit above in LTSpice. For the voltage source, select Advanced and use PULSE function : 
2. Set based on your chosen value above and = .
3. Set the simulation stop time to be 2 to 3 cycles of the period that you have calculated in Step 2.
4. Simulate and plot and . From the plot of , measure the simulated time constant value using cursors. Attach the plots with the cursors below.

* = \_\_\_\_\_\_\_\_\_\_\_\_\_*

1. Insert an internal resistance where = 50Ω into the circuit as below and from the plot of , measure the simulated time constant value using cursors. Attach the plots with the cursors below.



* = \_\_\_\_\_\_\_\_\_\_\_\_\_*

Comment on the effect of the internal resistance in the signal generator.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Repeat the steps for the L-R circuit shown below. [30%, 60mins]



*Formula of Time Constant,* ****** *= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

Choose the values of R and L to obtain a time constant of ( **Last two Digits of Matriculation Number + 5 )** **μs**

***R*** *= \_\_\_\_\_\_\_\_\_* ***L*** *= \_\_\_\_\_\_\_\_\_  = \_\_\_\_\_\_\_\_\_\_\_\_\_*

With the calculated time constant above, calculate the amount of time required for to reach approximately 99% of steady-state value.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Choose a period for that will allow to charge up to full scale. is shown as below. Draw the expected signal on the waveform below.

*, Period of = \_\_\_\_\_\_\_\_\_\_\_\_\_*

1. Set up the circuit above in LTSpice. For the voltage source, select Advanced and use PULSE function : 
2. Set based on your chosen value above and = .
3. Set the simulation stop time to be 2 to 3 cycles of the period that you have calculated in Step 2.
4. Simulate and plot and . From the plot of , measure the simulated time constant value using cursors. Attach the plots with the cursors below.

* = \_\_\_\_\_\_\_\_\_\_\_\_\_*

1. Insert an internal resistance where = 50Ω into the circuit as below and from the plot of , measure the simulated time constant value using cursors. Attach the plots with the cursors below.



* = \_\_\_\_\_\_\_\_\_\_\_\_\_*

Comment on the effect of the internal resistance in the signal generator.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **AC Analysis**

Using the formulae below, design the values of R, C or L, and frequency to achieve a phase difference of 45° between and **.**

* Available component values can be found in “DSA Component List” in IVLE’s Lab folder.
* **Frequency should be around 10KHz**.
* **Phase difference between two sinusoids:**, where is the time difference between their peaks, is the time period of the signals, is the frequency of the signals.

1. RC Circuit [20%, 30mins]

|  |  |
| --- | --- |
|  | Phase difference of  with respect to , . Thus  leads . As , the current leads. Power factor of RC load is leading. |

**R** = \_\_\_\_\_\_\_\_\_\_ **C** = \_\_\_\_\_\_\_\_\_\_\_ **Frequency of Input Sine Wave** = \_\_\_\_\_\_\_\_\_\_

Simulate the circuit above. Obtain the time difference between and and attach the

plots with the cursors below.

*Phase Difference,*

1. R-L Circuit [20%, 30mins]

|  |  |
| --- | --- |
|  | Phase difference of  with respect to ,  Thus lags . As , the current lags . Power factor of RL is lagging. |

**R** = \_\_\_\_\_\_\_\_\_\_ **L** = \_\_\_\_\_\_\_\_\_\_\_ **Frequency of Input Sine Wave** = \_\_\_\_\_\_\_\_\_\_

Simulate the circuit above. Obtain the time difference between and and attach the

plots with the cursors below.

*Phase Difference,*

*\*REMINDER\** **Please rename the filename to include your matriculation number before submission.**