Lab4 Report **23.75/25**

Objectives:

1. To understand the step response of RC and RL circuit
2. To calculate the voltage of the step response of an RC circuit
3. To calculate the voltage of the step response of an RL circuit

Part I: Step Response of an RC Circuit

Table I

| R/C | 100kΩ/1uF | 10kΩ/1uF | 5kΩ/2uF | 1kΩ/1uF |
| --- | --- | --- | --- | --- |
| Calculation τ | = 0.1 | = 0.01 | = 0.01 | = 0.01 |
| Simulation τ | 0.1 | 0.01005 | 0.01005 | 0.00105 |

Simulation result:

| 100kΩ/1uF | 10kΩ/1uF |
| --- | --- |
| 5kΩ/2uF | 1kΩ/1uF |

Part II: Step Response of an RL Circuit

Table I

| R/L | 500Ω/0.5H | 250Ω/0.25H | 100Ω/0.1H | 100Ω/0.25H |
| --- | --- | --- | --- | --- |
| Calculation τ | = 0.001 | = 0.001 | = 0.001 | = 0.0025 |
| Simulation τ | 0.00105 | 0.00105 | 0.00105 | 0.00255 |

Simulation result:

| 500Ω/0.5H | 250Ω/0.25H |
| --- | --- |
| 100Ω/0.1H | 100Ω/0.25H |

Discussion:

1. When the value of the resistor become smaller and the value of the capacitor remains unchanged. Then the value of the output voltage will reach the equilibrium voltage quickly. From the above simulation curve, the curve of the 1kΩ/1uF case is much steeper and fewer time to reach 0.632Vs than the curve of the 100kΩ/1uF case. This means if the value of resistor changes, it will change the value of time constant so the time that the capacitor can reach to the equilibrium voltage will also be affected. Then if we consider the output voltage at the same time for those different case, the output voltage will be lower if the value of the resistor is higher when compare to other cases.
2. When we change the input step signal to a square signal with a frequency of 1000Hz. The input voltage become a periodic square signal that oscillating between 0 and 1, and the output voltage will have negative value for some time. Furthermore, the capacitor may not have enough time for fully charge up or discharge due to the square signal. Therefore, the final voltage of the capacitor will be less then the input voltage so it will not same as the step input signal that the capacitor can reach the equilibrium voltage finally.

Conclusion:

For the RC circuit, when the switch is closed, the current starts flow through and the capacitor will store the electrical energy by storing the charge.

If the value of the resistor is smaller, then the current will be larger by V=IR. Also, if the value of the capacitor is smaller, then the voltage of the capacitor is larger when the charge is unchanged by Q=CV.

Therefore, the value of resistor and capacitor determine the time that how quickly the capacitor can reach the equilibrium voltage. If the value of the RC is smaller, then the capacitor can reach the equilibrium voltage more quickly.

For the RL circuit, when the switch is closed, then the rate of change of current become very larger as the initial current is zero, therefore, the inductor will store lots of energy and reach Vs initially. However, when the switch is closed for a while, the rate of change of current will become lower and zero finally as it is constant current. Then the voltage across the inductor will drop from Vs to zero.

Also, the value of resistor is smaller, then the current will be larger so it flow through the inductor for larger current for induced the voltage. If the value of the inductor is high, then it can induce higher voltage by v = L for the same current.

Therefore, the value of resistor and inductor determine the time that how quickly the inductor drop from the Vs to zero. If the values of L/R is small, then the inductor will become zero more quickly.