IC160P-Electrical Systems Around Us

Transient Response of of R – L – C Circuits

BY ADARSH SANTORIA (B21176)

1. Theory

In this experiment, the circuit connections are similar to those for the Frequency Response experiment. You are required to choose appropriate component values among the ones available in the laboratory. Note down your observations and readings.

2. Apparatus Required

1. Potentiometer
2. Capacitor
3. Inductance
4. Connecting Wires
5. Oscilloscope
6. Square Wave Generator

3. Procedure

After connecting the circuit, apply a square wave of desired frequency to your circuit and observe the voltage/current for different circuit components on the CRO. Observe the following and note your readings.

• For R − C circuits, measure the Settling Time. Calculate the approximate theoretical value based on the time constant.

For R - C circuits:

R = 1985 ohm

C = 72nF

Time Constant (T) = RC

142.92**μs**

• Change the value of resistance for the above circuit and observe the transient response. How can you infer the results?

T is proportional to R. This implies more is R , more will be T and more will the time to be taken for settling and vice versa.

Here,

Settling Time is 571.68 **μs** (Theoritically)

Settling Time is 480 **μs** (Practically)

• For an R − L − C circuit, observe the transient response of voltage across resistor and measure Rise Time, Settling Time and Overshoot. Calculate the theoretical values of the same and compare both.

For R – L - C circuits:

R = 40 ohm

C = 72nF

L=1mH

For these parameters, all the calculations and values with comparison is displayed in last page of this report with handly solutions.

• For the above R − L − C circuit, vary the resistance to observe underdamped, overdamped and critically damped response. Note your readings and observations.

4. Observations

Rise Time (tr) =9.6 **μs**
Settling Time (ts) = 1.7 **μs**
Underdamped Response is generated.
We can also verify this as

$$\left(\frac{R}{2L}\right)^2 < \frac{1}{LC}$$

Experiment - 1

RC :

$R = 1985\ \Omega$
$C = 72\ nF$
$L = 1mH$

$\tau = RC$
$= 142920 \times 10^{-3}\ s$

Settling time $= 4\tau$
$= 571.68\ \mu S$ (Theoretical)

Settling time $= 480 \mu S$ (Experimental)

RLC :

$R = 40\Omega$
$L = 1mH$
$C = 72nF$

$\xi = \frac{R}{2}\sqrt{\frac{C}{L}}$

$= 0.17$

$\theta = \cos^{-1}(\xi)$
$= 80.22°$

$\omega_n = \frac{1}{\sqrt{LC}}$

$= 117.851 \times 10^{3}$
$= 117851$ rad/s

$\omega_d = \omega_n \times \sqrt{1-(\xi)^2}$
$= 107367.37$ rad/s

Theoritical

Rise time (t_r) $= \frac{\pi - \theta}{\omega_d}$

$= 9.29 \times 10^{-6}\ s$
$= 9.29\ \mu s$

Settling time (t_s) $= \frac{4}{\xi \omega_n}$

$= 2.00 \times 10^{-6}\ s$
$= 2 \mu s$

Overshoot ($M_{p\%}$) $= e^{\frac{-\pi\xi}{\sqrt{1-\xi^2}}} \times 100$

$= 58.35\%$

Practical

Rise time (t_r) $= 9.6\ \mu s$

Settling time (t_s) $= 1.7 \mu S$

~~Overshoot ($M_{p\%}$)~~ -

Amit