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S. Y. B. Tech. (Electrical and Computer Engineering)

Semester: IV | **Subject:** Electrical Circuit Analysis

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Roll No: 29 | **Batch:** A2

Experiment No: 09

Name of the Experiment: Studying transient response of RLC series circuit using MATLAB Simulink.

Performed on: 8/11/2022

Submitted on: 22/11/2022

Marks	Teacher's signature with Date
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Aim: To observe the transient response of RLC series circuit using MATLAB Simulink.

Prerequisite: Knowledge of RLC circuits and MATLAB Simulink.

Theory:

The transient response is the fluctuation in current and voltage in a circuit (after the application of a step voltage or current) before it settles down to its steady state.

Transient Response of Circuit Elements:

A. Resistors: As has been studied before, the application of a voltage V to a resistor (with resistance R ohms), results in a current I, according to the formula: I = V/R
The current response to voltage change is instantaneous; a resistor has no transient response.

B. Inductors: A change in voltage across an inductor (with inductance L Henrys) does not result in an instantaneous change in the current through it. The i-v relationship is described with the equation: v=L di/ dt This relationship implies that the voltage across an inductor approaches zero as the current in the circuit reaches a steady value. This means that in a DC circuit, an inductor will eventually act like a short circuit.

C. Capacitors: The transient response of a capacitor is such that it resists instantaneous change in the voltage across it. Its i-v relationship is described by: i=C dv /dt
This implies that as the voltage across the capacitor reaches a steady value, the current through it approaches zero. In other words, a capacitor eventually acts like an open circuit in a DC circuit.

In the R-L-C series circuit, the three components are all in series with the voltage source. The governing differential equation can be found by substituting into Kirchhoff's voltage law(KVL) the constitutive equation for each of the three elements. From the KVL,

$$V_R + V_L + V_C = V(t)$$

where V_R, V_L and V_C are the voltages across R, L, and C, respectively, and $V(t)$ is the time-varying voltage from the source.

Damping of the RLC circuit affects the way the voltage response reaches to final value. The governing equation for resistor, inductor, capacitor in series with voltage source is,

$$L\frac{d^2i}{dt^2} + R\frac{di}{dt} + \frac{i}{C} = V$$

This is the equation for oscillator with damping and driving function. Solving the characteristic equation gives two roots s_1 and s_2, where $s_1 = -\alpha + \beta$ and $s_2 = -\alpha - \beta$.

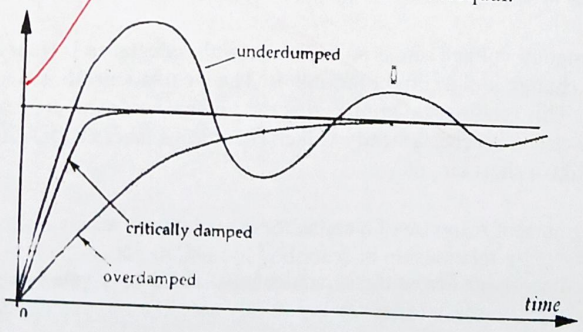
$$\alpha = \frac{R}{2L}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\beta = \sqrt{\alpha^2 - \omega_0^2}$$

Depending on values of α and ω_0, there are three cases.

1. Underdamped response: Here $\alpha > \omega_0$ and roots are complex conjugate.
2. Critically damped response: Here $\alpha = \omega_0$ and roots are real and equal.
3. Overdamped response: Here $\alpha < \omega_0$ and roots are real and unequal.



Procedure:

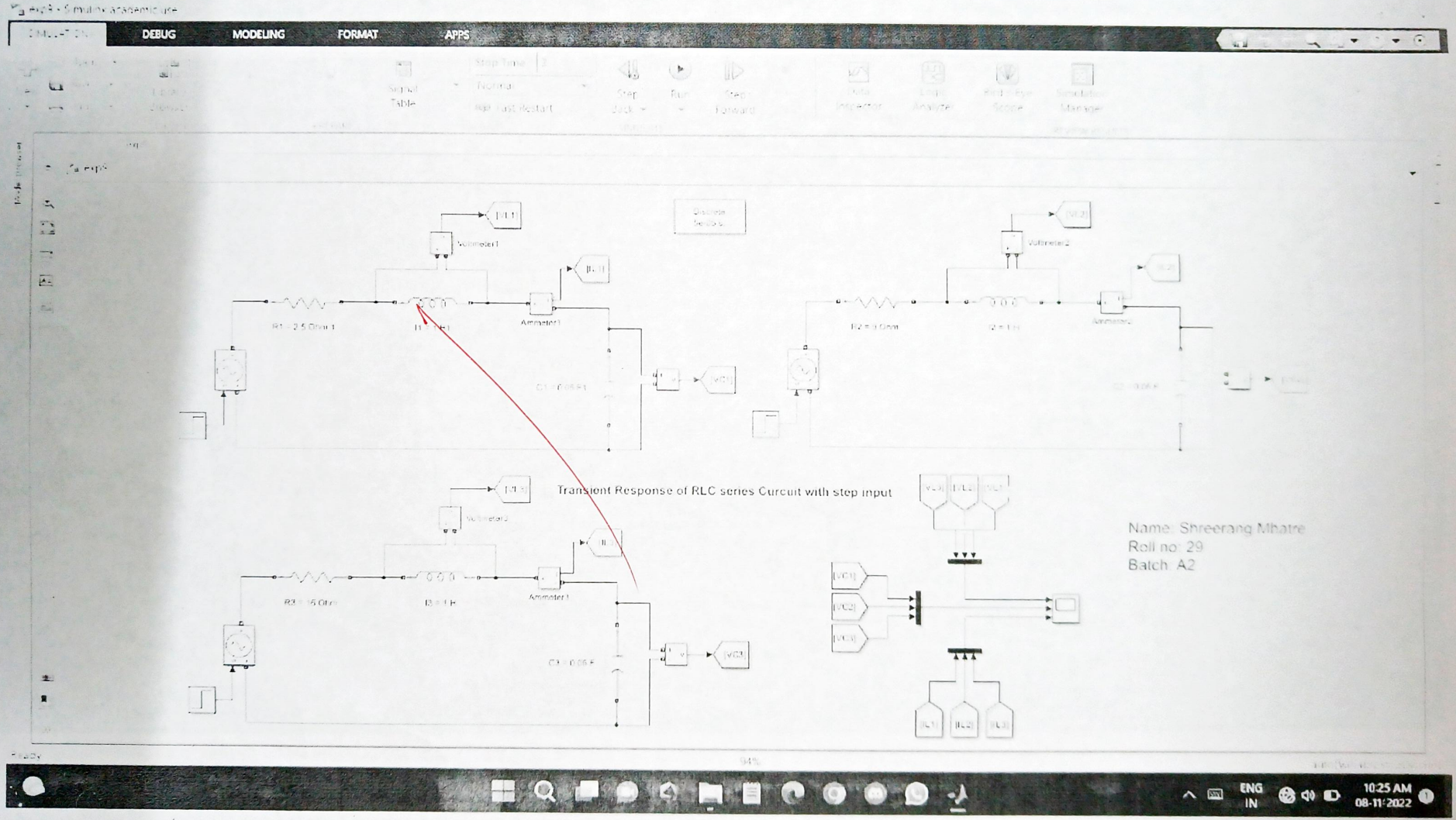
1. Start MATLAB.
2. Start Simulink, open the blank model.
3. Build the circuit as given in the class and measure voltage across capacitor, inductor separately and also measure current in the circuit.
4. Copy the circuit into two, but only with two different values of resistor. Select the values of resistor such that you will get all the three damping conditions.
5. Observe the waveforms on scope such that all V_C are seen on one graph and same for V_L and I_L.

Activity:

Attach screenshots of code and output.

Post Lab Questions:

1. What is transient?
2. Why transient response occur in electric circuit?
3. Define time constant of RL and RC circuit.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Transient Response of RLC series Circuit with step input
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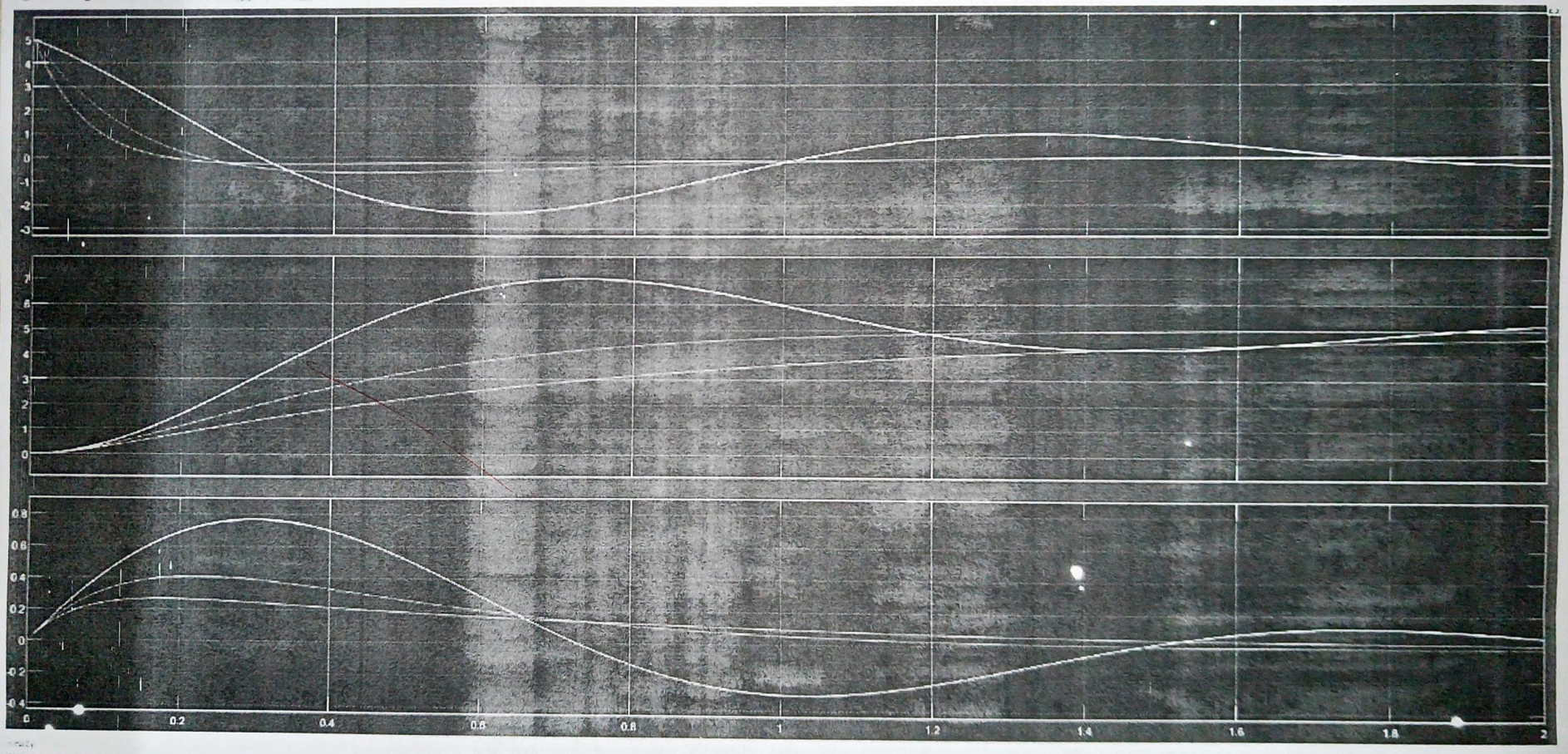
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* Post lab Question:

Q 1) what is transient?

→ The transient response is the fluctuation in current and voltage in a circuit (after the application of a step voltage or current) before it settle down to its steady state.

Q 2) why transient response occur in electric circuit?

→ Transients in electric circuits occur due to the presence of energy storage elements (i.e, inductors and capacitors). Transients in electric circuits can be excited by initial conditions, by sources, or by both.

Q 3) Define time constant of RL and RC circuit.

→ It is a measure of time required for certain changes in voltages and currents in RC and RL circuits. Generally, when the elapsed time exceeds five time constants (5τ) after switching has occurred, the currents and voltages have reached their final value, which is also called steady-state response.