Expt. No.: 07
Name of Expt.: Transient Characteristics of RL series circuit using MATLAB.

Objectives:
1. To analyze the transient response of an RL series circuit when a step voltage is applied.
2. To observe how current changes over time during the transient period.
3. To determine the time constant ($\tau = L/R$) and its effect on circuit behavior.
4. To simulate and plot the exponential growth of current using MATLAB.
5. To understand the energy storage and dissipation in inductor and resistor respectively.
6. To validate theoretical calculations with MATLAB simulation results.
7. To study the effect of varying resistance (R) and inductance (L) on transient characteristics.

Theory: The transient analysis of an RL series circuit involves studying the behavior of current when a sudden disturbance, such as a ground fault, occurs. A ground fault causes a sudden application of voltage across the circuit, producing a transient current that decays over time due to the presence of inductance (L) and resistance (R). Understanding this transient behavior is essential in power systems for designing protection schemes and ensuring equipment safety.
In an RL circuit, the current does not change instantaneously due to the inductor's opposition to sudden changes (Lenz's Law). The transient response is governed by a first-order differential equation derived from Kirchhoff's Voltage Law (KVL):

$L (dI/dt) + R * I = V(t)$
Here,
- I(t) is the instantaneous current,
- L is the inductance in henrys,
- R is the resistance in ohms,
- V(t) is the source voltage, often modeled as a sinusoidal function during faults.

In MATLAB, the differential equation is solved symbolically using dsolve. The specific code line used:
a = dsolve(L*diff(I, t) + I*R == Vmax * sin(2*pi*f*t + alpha), I(0) == 0);
solves the equation for current I(t) where the source voltage is sinusoidal, representing a ground fault scenario. The initial condition I(0) = 0 assumes no current before the fault occurs.
Here,
- Vmax is the peak voltage,
- f is the frequency,
The solution gives the complete time-domain expression for current, including both steady-state and transient components. MATLAB is used to plot and analyze the current waveform to understand its nature and decay behavior. This helps visualize how the RL circuit responds immediately after a fault and how quickly it stabilizes, which is crucial in designing fault-tolerant electrical systems.

Required Apparatus:

I) 220 V 50 Hz AC supply
ii) Computer
iii) MATLAB Software

Circuit Diagram:

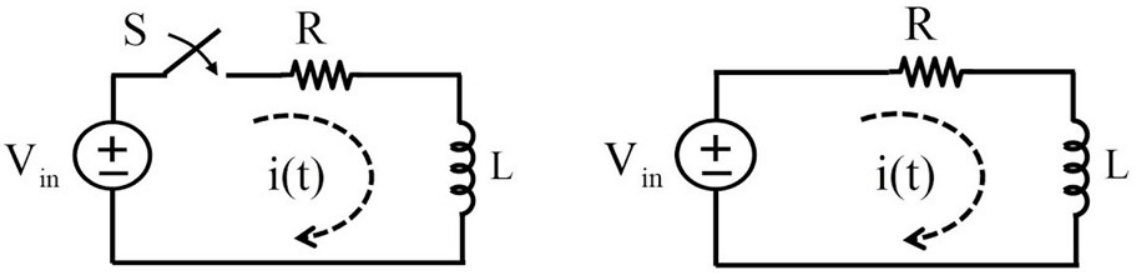

Fig-7.01: Circuit Diagram for Transient Characteristics of RL series circuit

MATLAB Code:

```
clc;
clear all;
R = 50;
L = 300;
Vmax = 100;
f = 1;
alpha = pi/3;
w = 2*pi*f;
syms I(t)
a = dsolve(L*diff(I, t) + I*R == Vmax * sin(2*pi*f*t +
alpha), I(0) == 0);
ezplot(a)
xlabel('T(s)')
ylabel('I(A)')
title('Transient Response of RL Circuit')
grid on;
```

Result:

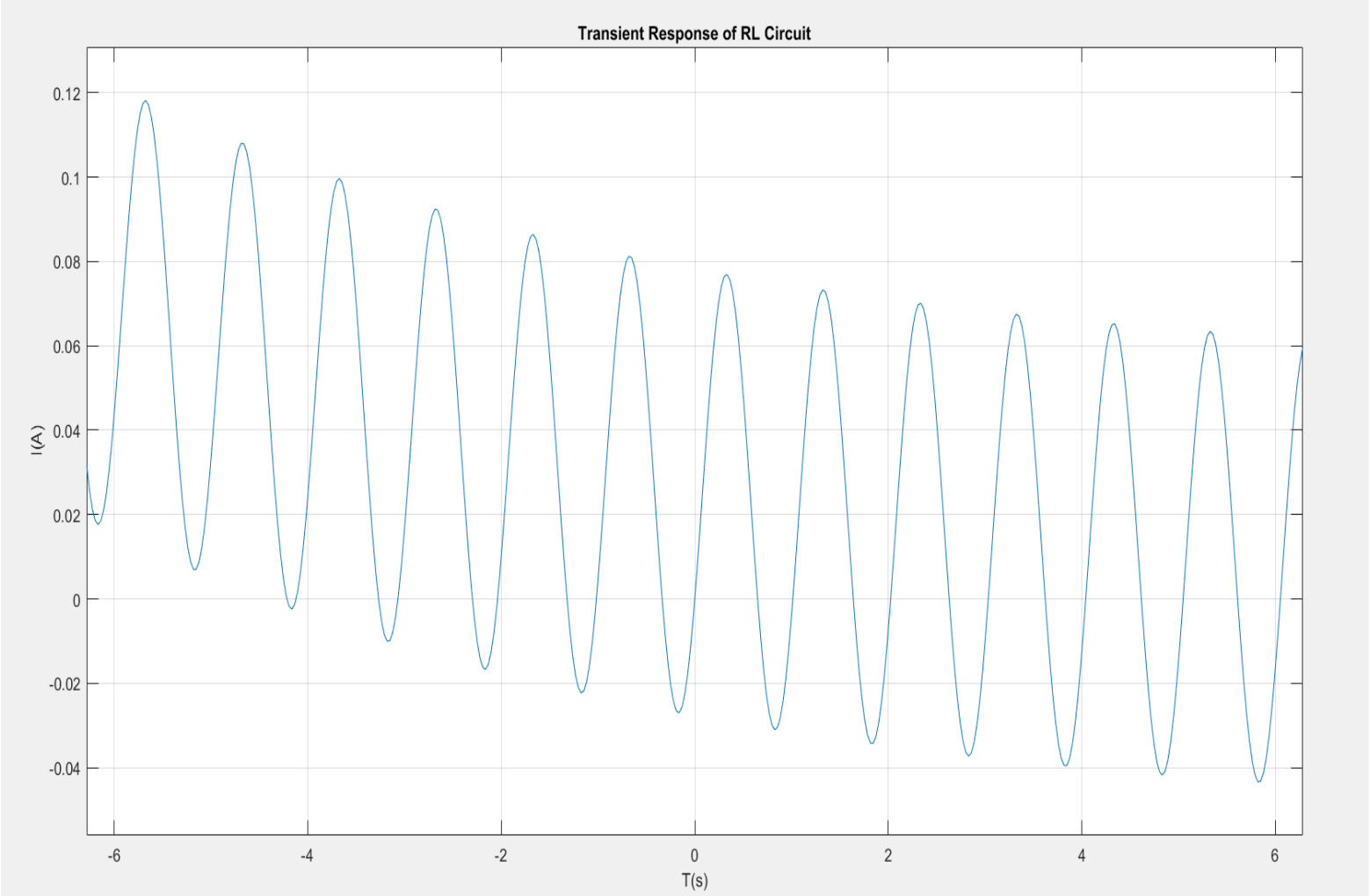

Fig-7.02: Output waveshape for Transient Characteristics of RL series circuit using MATLAB.

Discussion: The current waveform shows an oscillatory pattern due to the sinusoidal source, while the amplitude gradually settles to a steady-state value. This is consistent with theoretical expectations where the transient component decays exponentially, leaving only the steady-state response. The time constant ($\tau = L/R$) controls the rate of decay, and from the waveform, it is evident that the transient decays within a few cycles.

Applications:

1. Design of Power System.
2. Control System and Analysis
3. Testing of equipments

Conclusion: The experiment successfully analyzed the transient response of an RL series circuit using MATLAB. It demonstrated how the circuit responds to sudden voltage application, particularly under fault conditions.