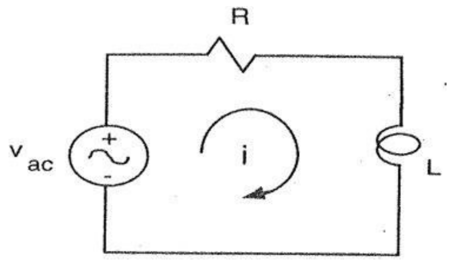
Title of the Exercise: AC Energization of an RL Circuit
Date: 4.9.2020
Aim: To Simulate the dynamic modal of a RL circuit and plot Voltage and current at various terminals and also analyze the theoretical results.
Tool used: MATLAB

Electrical Circuit:



Parameters used for the study:

Input : R = 0.4 ohm, L = 0.04 H, we = 314 rad/s, Vac = 100 V.

$$V_{ac} = iR + L\frac{di}{dt}$$

$$i(t) = \frac{1}{L}\int_0^t (V_{ac} - iR)dt + i(0)$$

$$i(t) = \underbrace{Ae^{-t/\tau}}_{\text{transient}} + \underbrace{\frac{V_{pk}}{|Z|}\sin(\omega_s t + \theta - \phi)}_{\text{steady-state}}$$

$$i(t) = -\frac{V_{pk}}{|Z|}\sin(\theta - \phi)e^{-t/\tau} + \frac{V_{pk}}{|Z|}\sin(\omega_s t + \theta - \phi)$$

Output :

Theoretical Analysis: It's a transient circuit with an AC source. Using transient analysis we can find the current through the resistor and inductor.

Calculations (Predetermination):

Theoretical Analysis

Given- $R = 0.4\,\Omega$, $L = 0.04\,H$, $\omega = 314\,rad/s$

$|V_{ac}| = 100V$

Apply KVL in the loop,

$$V_{ac} = iR + L\frac{di}{dt}$$

By transient analysis, $i(t)$ can be expressed as,

$$i(t) = Ae^{-t/\tau} + \frac{V}{|z|}\sin(\omega_s t + \theta - \phi)$$

$$i(t) = -\frac{V}{|z|}\sin(\theta - \phi)e^{-t/\tau} + \frac{V}{|z|}\sin(\omega_s t + \theta - \phi).$$

$\theta = 0^{\circ}$; $\phi = \tan^{-1}\left(\frac{\omega L}{R}\right) = 88.17^{\circ}$

$\tau = \frac{L}{R} = 0.1$; $|z| = \sqrt{R^2 + \omega^2 L^2} = 12.5$

$$i(t) = 7.955\left[\sin(88.17)e^{-10t} + \sin(314t - 88.17^{\circ})\right)$$

$i(0) = 0\,A$

$i(0.5) = -7.899\,A$

$i(0.55) = 7.98\,A$

$i(0.6) = -7.89\,A$

Procedure for simulation study:

Step1-Initialize the input parameters and write coding for the as per requirement of plots in m file and save it

Step 2-open new Simulink and make mathematical modelling as per circuit diagram and save it

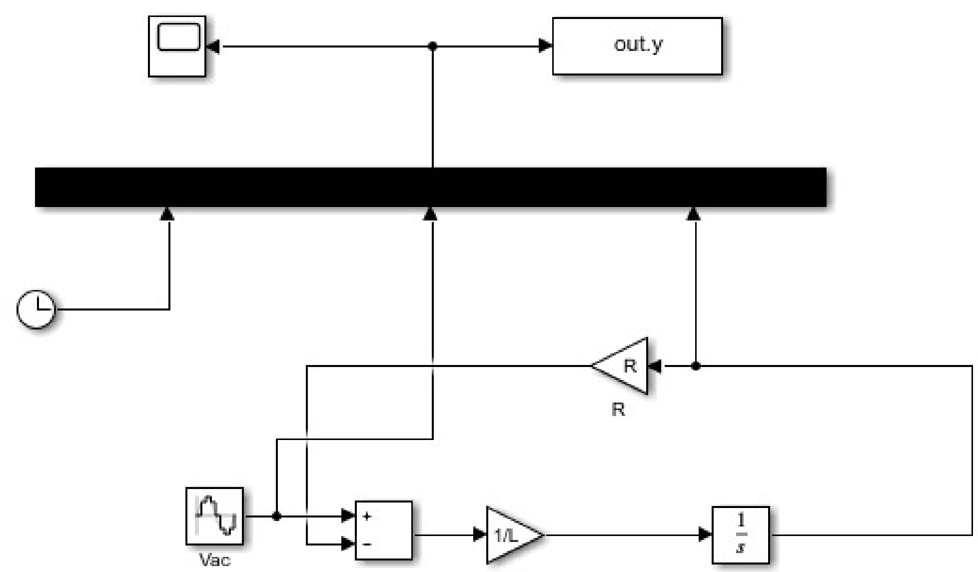
Step3-Run the m file first ,after that run Simulink file

Step4-View the result in Scope

Step5- Again run m file and view the plots

Step6-Make various plots and write the Results. Run Simulink file and view the result in Scope.

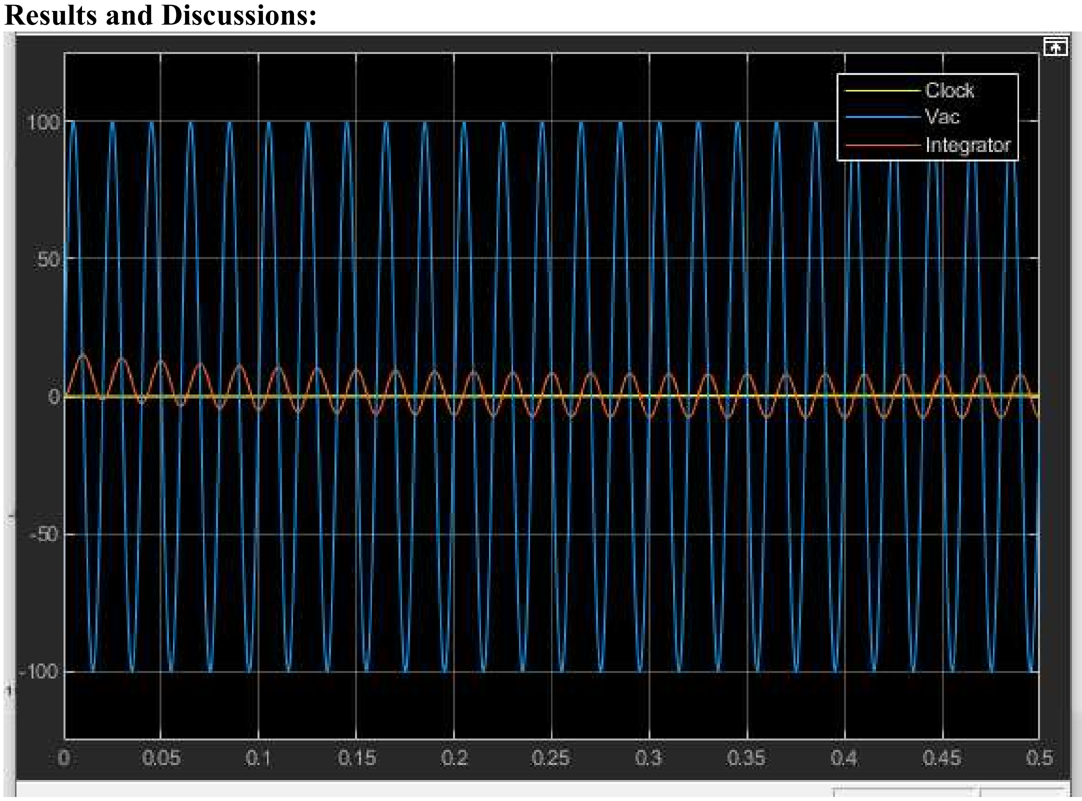
Simulation Diagram and m.file coding :

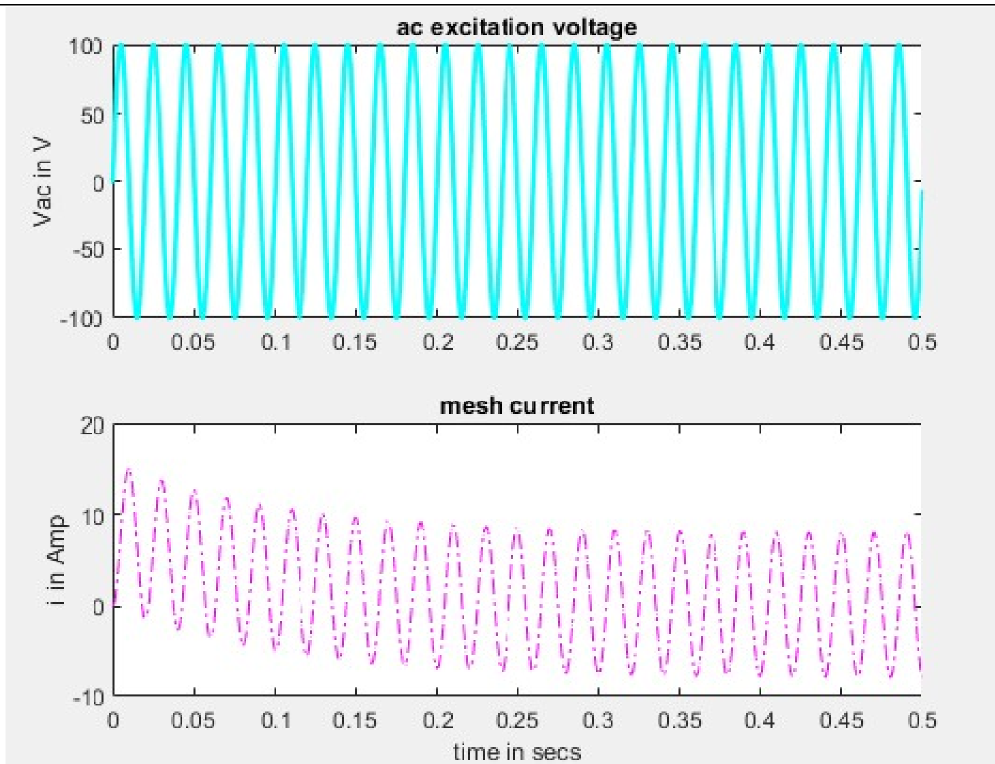


m.file coding :

```
R= 0.4;
L= 0.04;
we= 314;
Vac= 100;
iLo=0;
tstop= 0.5;
disp('run simulation')
keyboard
subplot(2,1,1)
plot(out.y.signals.values(:,1),out.y.signals.values(:,2),'c.')
title('ac excitation voltage')
ylabel('Vac in V')
subplot(2,1,2)
plot(out.y.signals.values(:,1),out.y.signals.values(:,3),'m-.')
title('mesh current')
ylabel('i in Amp')
xlabel('time in secs')
```

Results and Discussions:





Comparison:
(OBSERVATIONS)

TIME	Theoretical current value(A)	Stimulation current value(A)
0	0	0
0.5	-7.899	-7.9
0.55	7.98	8
0.6	-7.89	-7.9

Conclusion: The theoretical value is almost same as the simulation results.

Inference: The analysis of the dynamic model of the RL circuit provides the following inferences:

- Initially the mesh current value decreases exponentially and then reaches a steady state.
- The amplitude of the mesh current depends on the initial conditions of the circuit.

References: NIL