Department of Electrical and Electronic Engineering
Shahjalal University of Science and Technology

EEE 126: Electrical Circuit Simulation Laboratory

Experiment # 07: AC Transient Analysis.

Introduction:

A transient analysis deals with the behaviour of an electric circuit as a function of time . A circuit passes though a transition period before arriving steady-state condition when the circuit is switched with an ac supply, in which the currents and voltages are not periodic functions of time. If a circuit contains an energy storage element(s), a transient can also occur in a dc circuit after a sudden change due to switching.SPICE allows simulating transient behaviours, by assigning initial conditions to circuit elements, generating sources, and the opening and closing of switches. Students are advised to apply the techniques for transient analysis of simple circuit laws and to verify the SPICE results by hand calculations.

Theory: If an **RL** circuit is energized with and ac voltage then the expression of dynamic
Equilibrium is:

$$L\frac{di}{dt} + Ri = E_m \sin(\omega t + \lambda)$$

where, i is current through RL branch, $E_m \sin(\omega t + \lambda)$ is the applied voltage with λ phase.
The solution for current in RL circuit is:

$$i = \frac{E_m}{Z}\sin(\omega t + \lambda - \theta) - \frac{E_m}{Z}\sin(\lambda - \theta)\exp(-\frac{Rt}{L}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where, impedance, $Z = \sqrt{R^2 + (\omega L)}$ and phase difference between voltage and current, $\theta = \tan^{-}(\frac{R}{\omega L})$.
In (1) first and second terms are steady-state and transient respectively.

Similarly, for **RC** circuit the expression of dynamic Equilibrium is:

$$Ri + \frac{q}{C} = E_m \sin(\omega t + \lambda)$$

where, q is the charge and $i = \frac{dq}{dt}$
The solution for current in RC circuit is:

$$i = \frac{E_m}{Z}\sin(\omega t + \lambda + \theta) - \frac{E_m}{\omega RCZ}\cos(\lambda + \theta)\exp(-\frac{Rt}{L}) \quad \text{.......................................(1)}$$

where, impedance, $Z = \sqrt{R^2 + (1/\omega C)}$ and phase difference between voltage and current, $\theta = \tan^{-}(-R\omega C)$.

In (2) first and second terms are steady-state and transient respectively.

For **RLC** branch circuit the expression of dynamic Equilibrium is:

$$L\frac{d^2 i}{dt^2} + R\frac{di}{dt} + \frac{1}{C}\frac{dq}{dt} = E_m \sin(\omega t + \lambda)$$

If $\frac{R^2}{4L^2} > \frac{1}{LC}$ then expression of current can be written as follow:

$$i = \frac{E_m}{Z}\sin(\omega t + \lambda - \theta) + \frac{E_d}{bL}\exp(-at)\sinh bt - \frac{E_m}{Z}\sin(\lambda - \theta)\exp(-at)\cosh bt$$

If $\frac{R^2}{4L^2} < \frac{1}{LC}$ then expression of current can be written as follow:

$$i = \frac{E_m}{Z}\sin(\omega t + \lambda - \theta) + \frac{E_d}{\beta L}\exp(-at)\sin \beta t - \frac{E_m}{Z}\sin(\lambda - \theta)\exp(-at)\cos \beta t$$

where,

$$E_d = E_m \sin\chi - \frac{Qo}{C} - \frac{E_m \omega L}{Z}\cos(\chi - \theta) - \frac{E_m R}{2Z}\sin(\chi - \theta), a = \frac{R}{2L}, b = \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}},$$

$\beta = -jb$ and Q_o is charge in capacitor before switching.

Report

Practice problem 1:

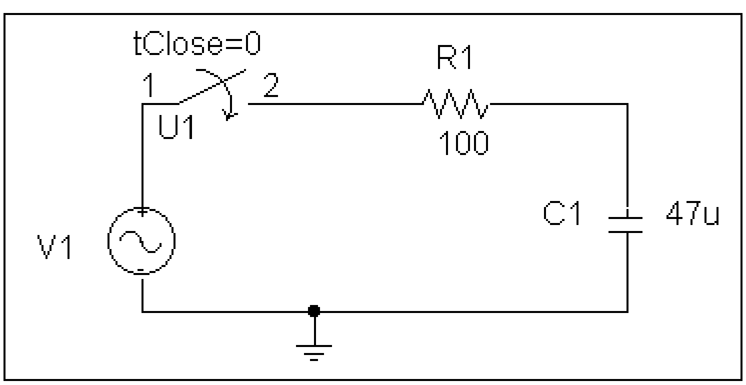

Figure 7.1

Practice Problem 2:

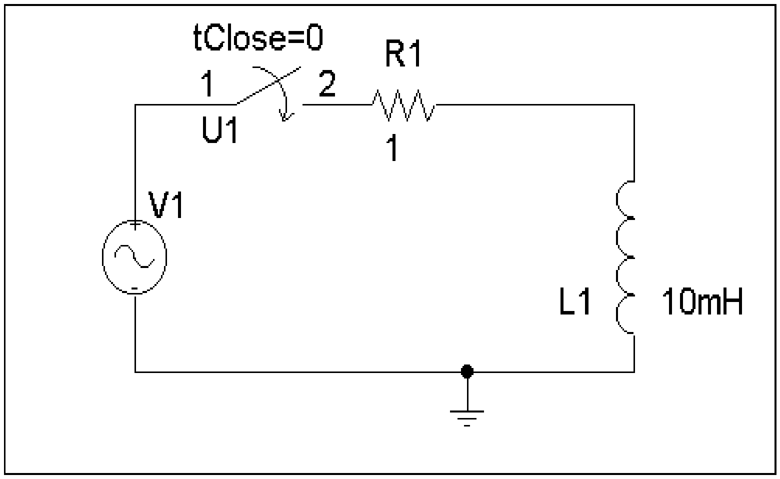

Figure 7.2

Practice Problem 3:

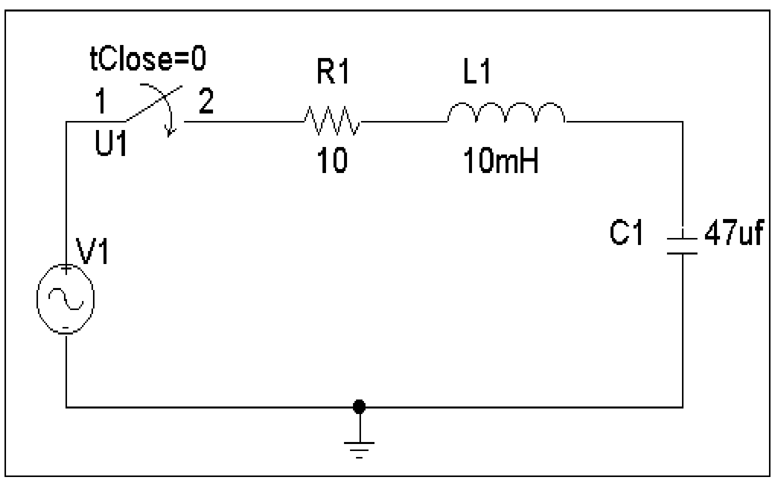

Figure 7.3

For all the circuits in the above figures

(a) Construct all the circuits for both netlist and schematic.
(b) For each circuit calculate *i* at t = 0, 2.5, 5, 7.5, 10 msec.
With V_m = 300 volts, frequency=50Hz and lamda χ =0, 30, 60 degree.
(c) Students will plot i, V_c , *and* V_L by using transient analysis for all the above circuits at different phase angle.

Pre-lab works :

(1) Students will plot i, V_c , *and* V_L by using transient analysis and that will be verified during labworks.

(2)They will calculate the maximum and minimum peak values of currents and voltages at transient condition and time required to reach steady state.

(3) For two different values of L, C, R measure maximum and minimum peak value at transient condition and time required to reach steady state.