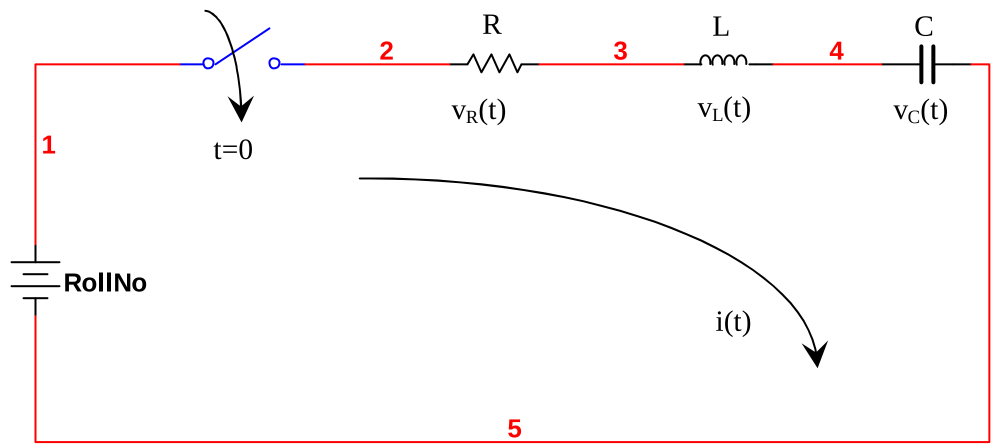
EXPEREMENT-9

AIM: To obtain the transient response of overdamped R-L-C series circuit for step voltage input using MULTISIM software.

SOFTWARE REQUIRED: MULTISIM software.

THEORY: Consider the following series R-L-C circuit. Let the switch is closed at t=0.



When switch is closed at t=0, apply KVL

$$L\frac{di(t)}{dt} + Ri(t) + \frac{1}{C}\int i(t)dt = V - - - - - (1)$$

Differentiate and put the values

$$\frac{di^2(t)}{dt^2} + \frac{R}{L}\frac{di(t)}{dt} + \frac{1}{LC}i(t) = 0 - - - - - (2)$$

For CF: It's A.E $\quad m^2 + \frac{R}{L}m + \frac{1}{LC} = 0$

$$m_1 \& m_2 = -\frac{R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$$

Let $\quad \alpha = -\frac{R}{2L} \;\&\; \beta = \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$

$$m_1 = \alpha + \beta \;\&\; m_2 = \alpha - \beta$$

$$CF = K_1 e^{m_1 t} + K_2 e^{m_2 t}$$

For PI: PI=0

So Complete solution i(t)=CF+PI

$$i(t) = K_1 e^{m_1 t} + K_2 e^{m_2 t} - - - - - (3)$$

Assuming $\left(\frac{R}{2L}\right)^2 > \frac{1}{LC}$ In this case β is positive, real number. Hence roots m_1 & m_2 are real but unequal. System will become over damped.

$m_1 = \alpha + \beta, \quad m_2 = \alpha - \beta$

If switch is closed at t=0

$i(0^+)=0$---------------------(4) put this in equation (3)

$$L\frac{di(0^+)}{dt} + Ri(0^+) + \frac{1}{C}\int i(0^+)dt = V$$

$$L\frac{di(0^+)}{dt} + R \times 0 + 0 = V$$

(at t= 0^+ , L will be open & C will be shorted)

$$\frac{di(0^+)}{dt} = \frac{V}{L} \quad \frac{A}{Sec} - - - - - (5)$$

Put condition of equation (4) & (5) in equation (3)

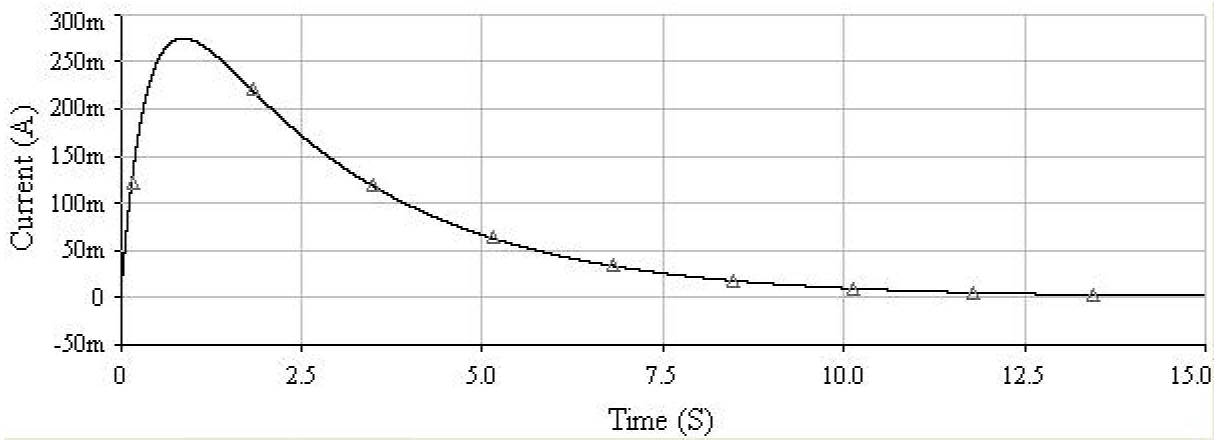
$K_1+K_2 = 0$--------------------(6)

And $\frac{V}{L} = K_1 m_1 + K_2 m_2 - - - - - (7)$

Solving equations (6) & (7) $K_1 = -\frac{V}{L(m_2-m_1)}$ & $K_2 = \frac{V}{L(m_2-m_1)}$, Putting in equation (3)

$$i(t) = \frac{V}{L(m_2-m_1)}(-e^{m_1 t} + e^{m_2 t}) - - - - - (3)$$

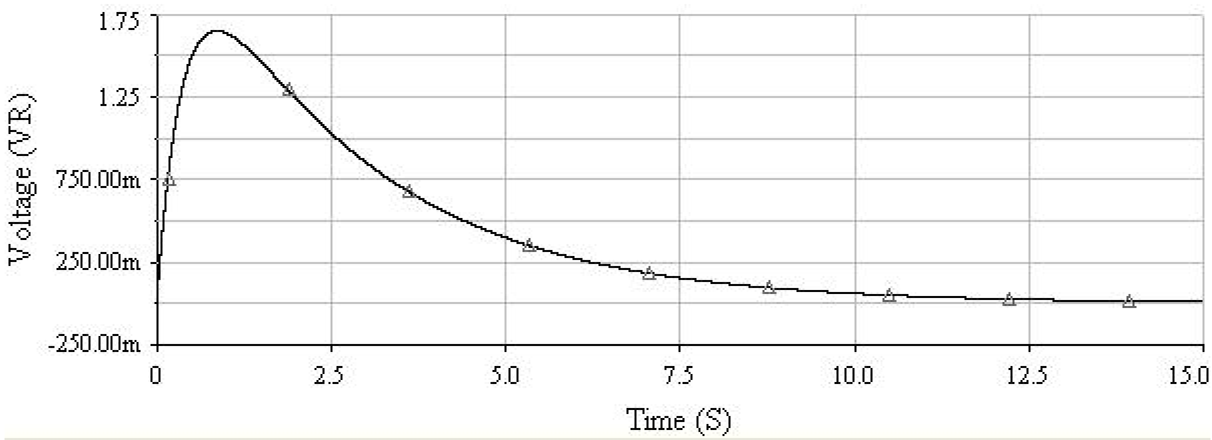
For V=2, R=6 ohm, L=2 H, C=500 mF, Trace of i(t) will be as shown bellow



Voltage across R

$$V_R(t) = i(t)R =$$

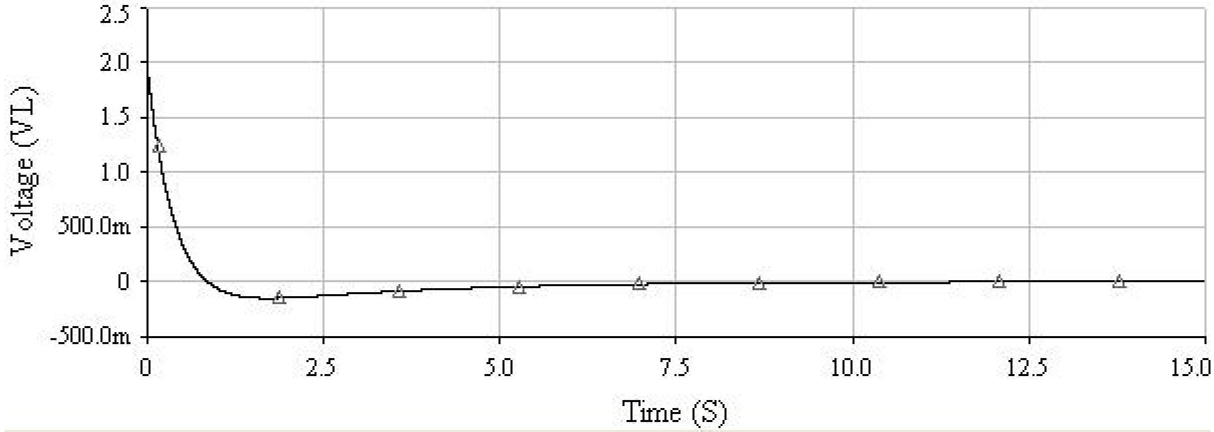
For V=2, R=6 ohm, L=2 H, C=500 mF, Trace of $V_R(t)$ will be as shown bellow



Voltage across L

$$V_L(t) = L\frac{di(i)}{dt} =$$

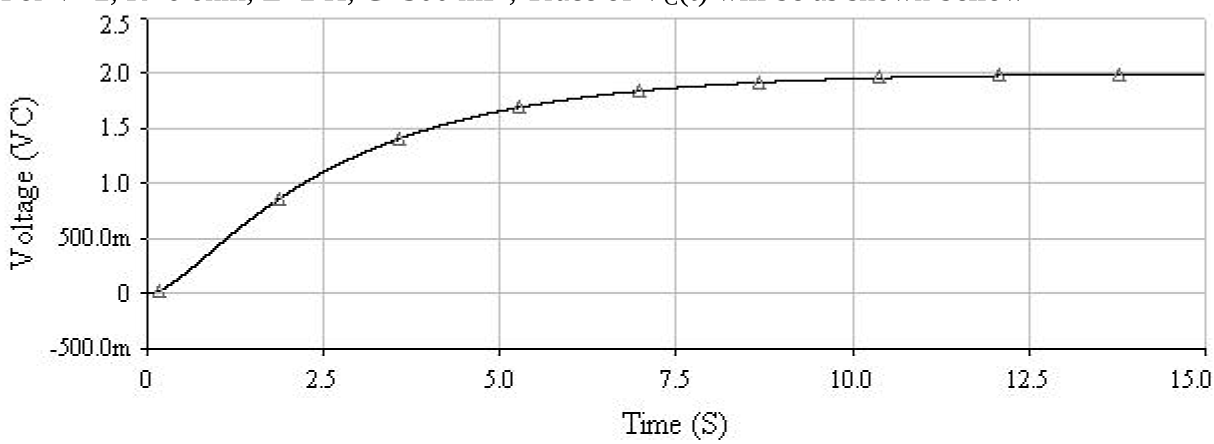
For V=2, R=6 ohm, L=2 H, C=500 mF, Trace of $V_L(t)$ will be as shown bellow



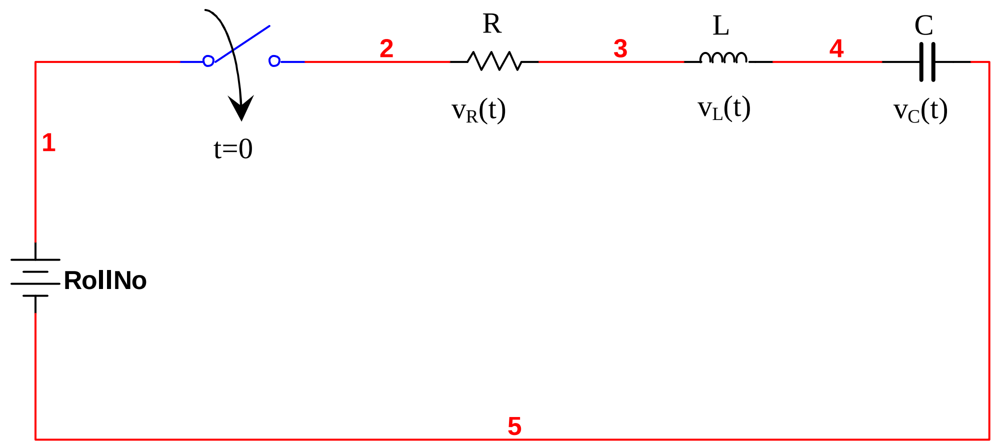
Voltage across C

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

For V=2, R=6 ohm, L=2 H, C=500 mF , Trace of $V_C(t)$ will be as shown bellow



SOFTWARE CIRCUITS:



CALCULATIONS: Calculate the expression of i(t), $V_R(t)$, $V_L(t)$ & $V_C(t)$

RESULT:

Please note the difference in critical damped and overdamped system response, see all graph carefully.

PRECAUTION And Do's & Don't:

1. Simulation time should be chosen properly.
2. Ground the circuit before simulation.
3. Design circuit carefully.
4. Save the file properly
5. Don't change the setting the software and computer.