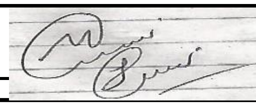
Department of Electrical Engineering
Assignment
Date: 13/04/2020

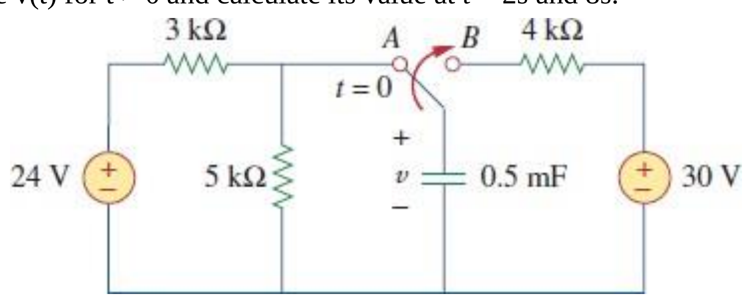
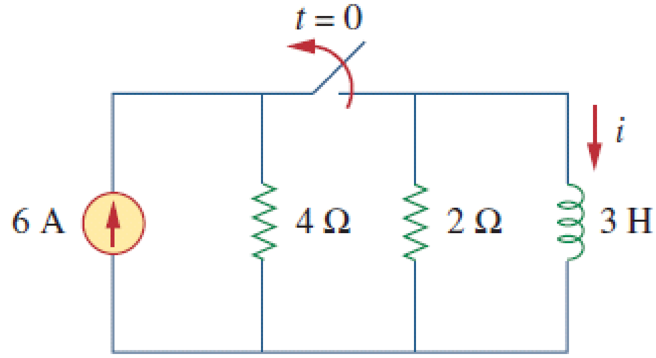
Course Details

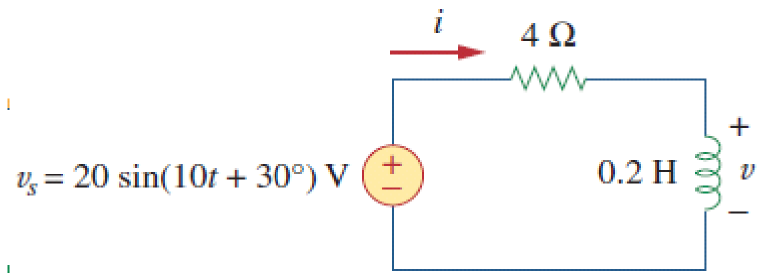
Course Title:	Electrical Network Analysis	**Module:**	4th
Instructor:	**Dr shehryar Shafique qureshi**	**Total Marks:**	30

Student Details

Name:	**M.Salman shahid**	**Student ID:**	**15006**

Student Signature: 

Q1.		The switch in Fig. 1 has been in position *A* for a long time. At t = 0 the switch moves to *B*. Determine v(t) for t > 0 and calculate its value at *t* = 2s and 8s.  **Figure 1**	Marks 06 CLO 01
Q2.		Determine the inductor current for both t >0 and t <0 for the circuit in Fig. 2.  **Figure 2**	Marks 06 CLO 01
Q3.		A series RLC circuit is described by $$L\frac{d^2i}{dt^2} + R\frac{di}{dt} + \frac{i}{C} = 10$$ Find the response when L = 0.5 H , R = 4 Ω and C = 0.2 F. Let *i*(0) = 1, *di*(0)/*dt* = 0	Marks 06 CLO 01

Q4.		A series RLC circuit has R = 100Ω, L = 240 H and C = 10mF. If the input voltage is v(t) = 10cos 2t, find the current flowing through the circuit.	Marks 06 CLO 03
Q5.		Find v(t) and i(t) in the circuit shown in figure 3.  **Figure 3**	Marks 06 CLO 03

1.	The switch in Fig. 1 has been in position A for a long time. At $t = 0$ the switch moves to B. Determine $v(t)$ for $t > 0$ and calculate its value at $t = 2$s and 8s.	Marks 06 CLO 01

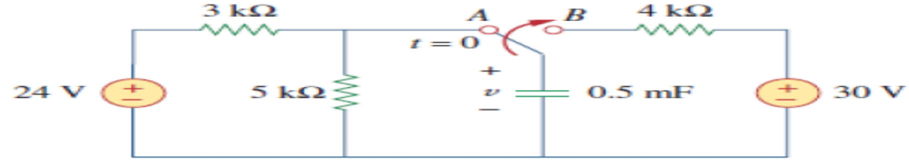


Figure 1

Solution:- for $t<0$ the switch is ~~open~~ at Position A. The capacitor act's like an open switch to DC but v is the same as the voltage across the 5kΩ resistor Hence the voltage across the capacitor just before $t=0$ is obtained by voltage division

In series the voltage is divide across resistor's

So to determine voltage at 5 kΩ resistor

$$V(0^-) = \frac{R_2}{R_1+R_2} V_1 = \frac{5}{5+3}(24) = 15V$$

Using the fact that capacitor voltage cannot change simultaneously.

$$V(0) = V(0^-) = V(0^+) = 15V$$

for $t>0$, the switch is at Position B. The Thevenin resistance connected to the capacitor is $R_{th} = 4k\Omega$ & the time constant is

$$\tau = R_{th}C = 4\times10^{3}\times0.5\times10^{-3} = 2s$$

$\therefore$ kilo $= 10^{3}$
milli $= 10^{-3}$

Since the capacitor act's like an open circuit to D-C at steady state $v(\infty) = 30V$
Thus

$$v(t) = v(\infty) + [v(0) - v(\infty)]e^{-t/\tau}$$
$$= 30 + (15 - 30)e^{-t/2} = (30 - 15e^{-0.5t})V$$

So now at $t = 2$

$$V(2) = 30 - 15e^{-1} = 24.48V$$

at $t = 8$

$$V(8) = 30 - 15e^{-4} = 29.72V$$

Q2.		Determine the inductor current for both t >0 and t <0 for the circuit in Fig. 2.	Marks 06 CLO 01

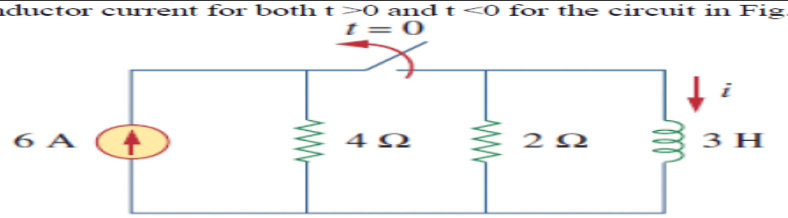
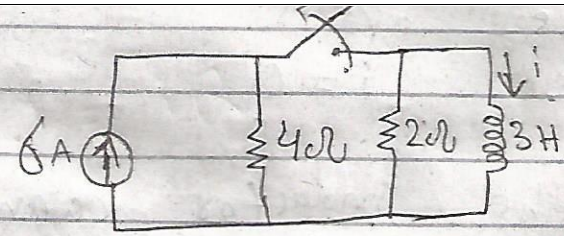


Figure 2

Sol:-

For t>0 the switch is open and the current flows toward resistor only



first we find voltage

$$V = iR$$
$$= (6A)(4)$$
$$= 24$$

The switch is opened so the inductor current cannot change instant

$$i(0^-) = \frac{24}{4} = 6A$$

$$i(0) = i(0^-) = i(0^+) = 6A$$

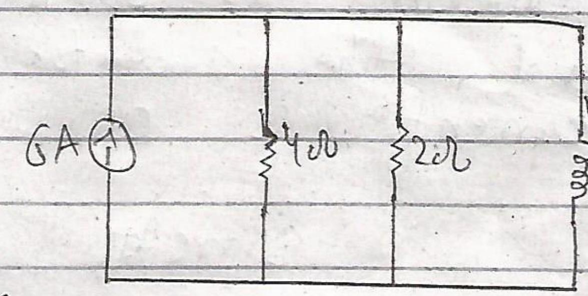
So the inductor current at opened switch t >0 is
$i(0) = 6A$

Now for t< 0 and the switch is closed

When $t<0$ the switch is closed

$$R_{eq} = \frac{R_1 \cdot R_2}{R_1+R_2}$$

$$i(\infty) = \frac{24}{1.33} = 18.004$$



$$R_{th} = \frac{4\times 2}{4+2} = 1.33\Omega$$

Now to find time Const τ

$$\tau = \frac{L}{R_{th}} = \frac{3H}{1.33\Omega} = 2.250$$

$$i(t) = i(\infty) + \left[i(0) - i(\infty)\right]e^{-t/\tau}$$

$$= 18.004 + \left[6 - 18.004\right]e^{-t/2.250}$$

$$= 18.004 + (-12A)e^{-t/2.250}$$

$$i(t) = 6.004\,e^{-2t}$$

So for $t>0$

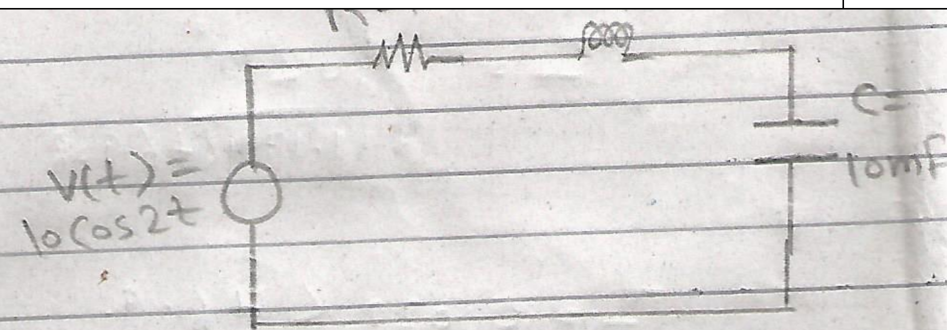
$$i(t) = 6A$$

$t<0$ $i(t)$ is equal to

$$i(t) = 6.004e^{-2t}$$

Q4.		A series RLC circuit has R = 100Ω, L = 240 H and C = 10mF. If the input voltage is v(t) = 10cos 2t, find the current flowing through the circuit.	Marks 06 CLO 03

Solution:-



Conversion of time domain to Phasor

$\omega = 2$

$v(t) = 10\cos(2t)$

$V = 10\angle 0^\circ$

$Z_L = j\omega L = j \times 2 \times 240H$

$Z_L = j480$

$Z_C = \frac{1}{j\omega C} = \frac{1}{j \times 2 \times 0.01} = -j50$

Total impedence Z equal

$Z = R + j\omega L + \frac{1}{j\omega C}$

$= 100\Omega + j480 - j50$

$Z = 100 + j430$

Conversion to Phasor

$Z = \sqrt{(100)^2 + (430)^2} \angle \tan^{-1}\left(\frac{430}{100}\right)$

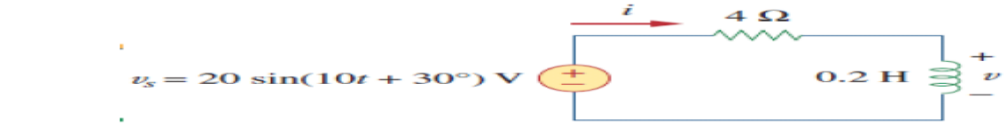
$Z = 441.474 \angle 76.908$

$$I = \frac{V_s}{Z}$$

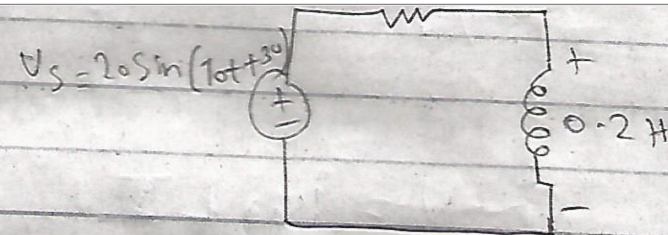
$$I = \frac{10\angle 0^\circ}{447.474\angle 76.908}$$

$$I = 0.022\angle 76.9$$

$$I_t = 0.022\cos(2\cancel{t+}76.908)$$

Q5.		Find v(t) and i(t) in the circuit shown in figure 3.  Figure 3	Marks 06 CLO 03

Solution:-



from voltage source
$20 \sin(10t + 30°)$

$\omega = 10$

$V_s = 20 \angle 30° \, V$

inductive impedance equal to

$Z_L = j\omega L$

from circuit figure

$= j10 \times 0.2$

$= j2 \, \Omega$

Now impedance Z

$Z = R + j\omega L$

$= 4 + j2$

Conversion to sinusiodal

$\sqrt{(2)^2 + (4)^2} \angle \tan^{-1}\left(\frac{2}{4}\right)$

$Z = 4.47 \angle 26°$

Now

$I = \frac{V_s}{Z} = \frac{20 \angle 30°}{4.47 \angle 26} = 4.472 \angle 4°$

$i(t) = 4.472 \sin(10t + 4^\circ)$

Now to find v(t)
from eq

$V = j\omega L I$

$V = j10 \times 0.2 \times 4.47 \angle 4$

Now Conversion to sinusoidal

$j10 \times 0.2$

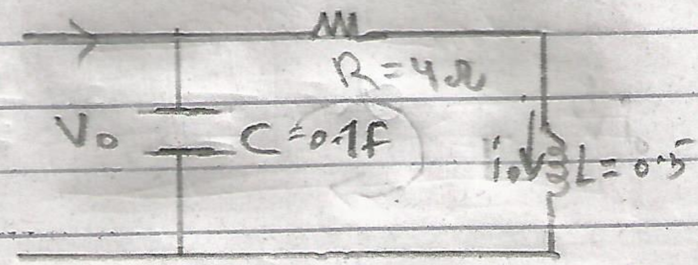
$\tan^{-1}\left(\frac{10}{0.2}\right) \angle 90^\circ$

$V = 2 \angle 90^\circ \times 4.47 \angle 4$

$V = 8.94 \angle 94^\circ$

$V = 8.94 \sin(10t + 94^\circ)$

Q3.		A series RLC circuit is described by $$L\frac{d^2 i}{dt^2} + R\frac{di}{dt} + \frac{i}{C} = 10$$ Find the response when L = 0.5 H , R = 4 Ω and C = 0.2 F. Let $i(0) = 1$, $di(0)/dt = 0$	Marks 06 CLO 01



Applying KVL

$$iR + L\frac{di}{dt} + \frac{1}{C}\int_0^t i\,dt + V_0 = 0$$

initial voltage in the capacitor $= V_0$

Second order

$$R\frac{di}{dt} + L\frac{di^2}{dt^2} + \frac{i}{C} = 0$$

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

initial value of derivative

$$Ri(0) + L\frac{di(0)}{dt} + V_0 = 0$$

$$\frac{di(0)}{dt} = -\frac{1}{L}\left(RI_0 + V_0\right)$$

$$\frac{di(0)}{dt} = \frac{-1}{0.5}\left(R(1) + 10\right)$$

$$s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$$

So ~~k~~now

$$\alpha = \frac{R}{2L} = \frac{4}{2(0.5)} = 4$$

$$w_o = \frac{1}{\sqrt{(0.5)(0.2)}} = 3.162$$

$$\alpha > w_o$$

so

response overdamped