19AIE 104 -INTRODUCTION TO ELECTRICAL ENGINEERING

Name: Rohith ND (21631)

QUESTIONS:

1.For the circuit containing a battery of voltage V_b= 10 volt , a resistor with resistance R=5 ohm and an inductor with inductance L=1 H ,plot the voltage across the inductor.

<u>Solution:</u>

V_b=10V; R= 5 Ω ; L = 1H ; V_L =?

$V_b = I*R + L\frac{di}{dt}$; $V_R(0)$= 0

$V_L = L\frac{di}{dt}$

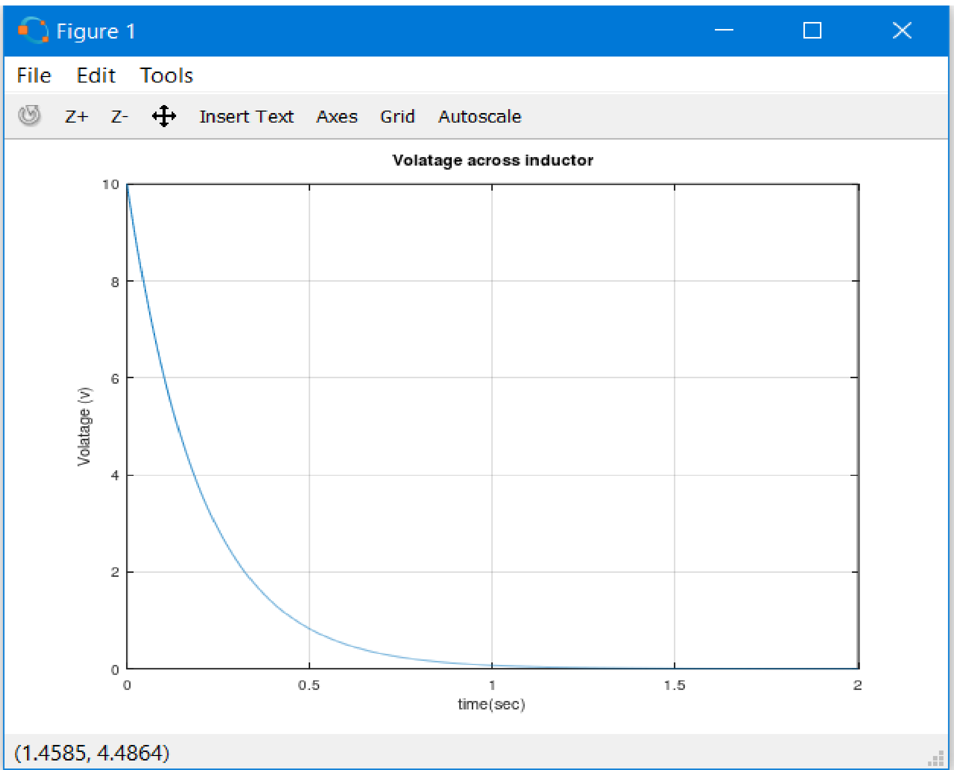
$V_b = I*R + L\frac{di}{dt} \Rightarrow 10 = 0 + L\frac{di}{dt}$

$V_L = L\frac{di}{dt} = 10\ V$

Thus the voltage across inductor is 10V at initial (i.e), at t =0.

Matlab:

```
clc;
clear all;
close all;

R=5;
L=1;
Vb=10;
delt = 0.001;
time_constant = L/R;

T= 10*time_constant;
i(1)=0;

t=0:delt:T;

A=-R*t/L;
for n=1:(length(t)-1)
%i(n+1)= i(n)+(delt*(((-i(n)*R)+Vb)/L));
vl=Vb*exp(A);
end
plot(t,vl);
title('Volatage across inductor');
xlabel('time(sec)');
ylabel('Volatage (v)');
grid('on');
```



2.Suppose at time t = 2 in the previous problem the battery is taken out of the circuit and replaced with a wire.Plot the current for the next 2 seconds.

Solution:

T= 2 seconds ; V_b=10V; R= 5 Ω ; L = 1H ; V_L =10V

I = I_0(1 - e^ $\frac{-\tau}{T}$)

$\tau=\frac{L}{R}$ => $\frac{1}{5}$ =0.2 s

After battery is removed

I = 2*(1-e^($\frac{0.2}{2}$))

= 2*(1-$e^{-0.1}$)

=2*(1- $\frac{1}{\mathrm{e}^{\wedge}0.1}$)

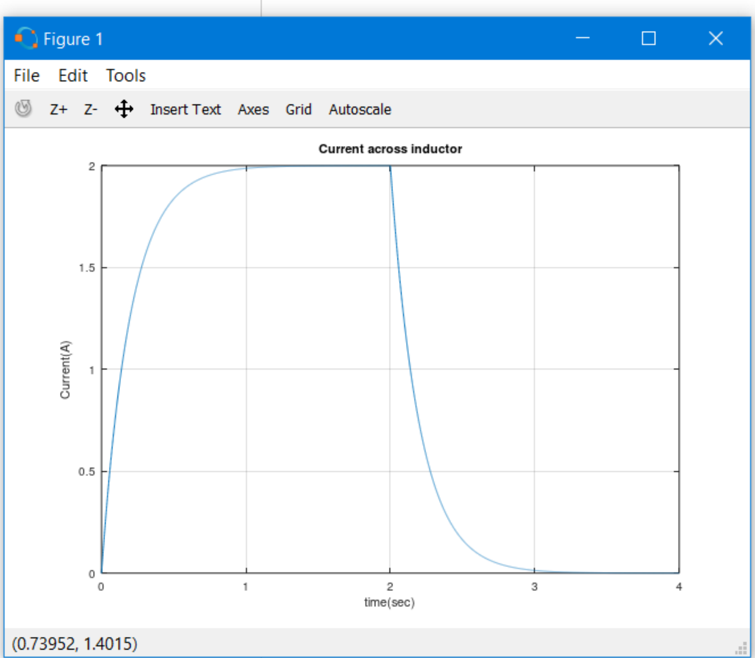
=2*(1- 0.904)

=2 * 0.096 => 0.192 A

Thus the current is 0.192A

Matlab:

```
clc;
clear all;
close all;
R=5;
L=1;
Vb=10;
delt = 0.001;
T=2;
t=0:delt:T;
t1=t;
i(1)=0;
for n=1:(length(t)-1)
i(n+1)= i(n)+(delt*(((-i(n)*R)+Vb)/L));
end
i1=i;
i(1)=i(end-1);
Vb=0;
T=4;
t=2:delt:T;
t2=t;
for n=1:(length(t)-1)
  i(n+1)=i(n)+(delt*(((-i(n)*R)+Vb)/L));
end
 i2=i;
 t3=[t1 t2];
 i3=[i1 i2];

plot(t3,i3);
title('Current across inductor');
xlabel('time(sec)');
ylabel('Current(A)');
grid('on');
```



3. For the circuit containing a battery of voltage VB = 15 volts, a resistor with resistance R ohms, and an inductor with inductance L = 5 henry, the circuit reaches the steady state at 0.25 seconds. Determine the resistance R. What is the maximum current in the circuit?

Solution:

V_b= 15v; R= R Ω ; L = 5 H ; T= 0.25 s

$I_{max} = \frac{Vb}{R}$

5 τ = 0.25 [steady state]

τ = 0.05 s

$\tau = \frac{L}{R}$

R= $\frac{L}{\tau}$ => $\frac{5}{0.05}$ = 100 Ω

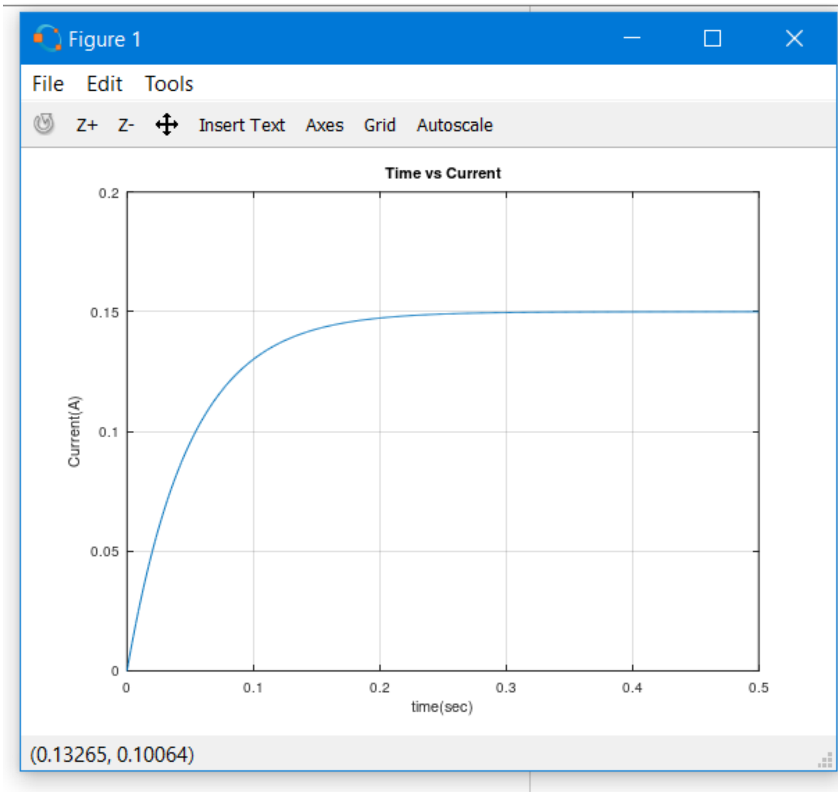
$I_{max} = \frac{Vb}{R}$ => $\frac{15}{100}$

I_{max} = 0.15 A

The Resistance is 100 Ω and the maximum current is 0.15A.

Matlab:

```
clc;
clear all;
close all;

R=100;
L=5;
Vb=15;
delt = 0.001;

time_constant = L/R;

T= 10*time_constant;
i(1)=0;

t=0:delt:T;

for n=1:(length(t)-1)
i(n+1)= i(n)+(delt*(((-i(n)*R)+Vb)/L));
%vl=Vb-vr;
end

plot(t,i);
title('Time vs Current');
xlabel('time(sec)');
ylabel('Current(A)');
grid('on');

```



4. For the above circuit (given in Q.No.3), plot the voltage across the resistor and the inductor.

Solution:

$V_L = L\frac{di}{dt}$; V_b= 15V; L= 5H

V_R= I*R ; t= 0 s

V_R = 0.15 * 100 = 5 V

$V_b = V_R + L\frac{di}{dt}$ (OR)

$V_L = V_b$ * (e ^ $\frac{-Rt}{L}$)

V_L = 15 * (e ^ $\frac{-100*0}{5}$)

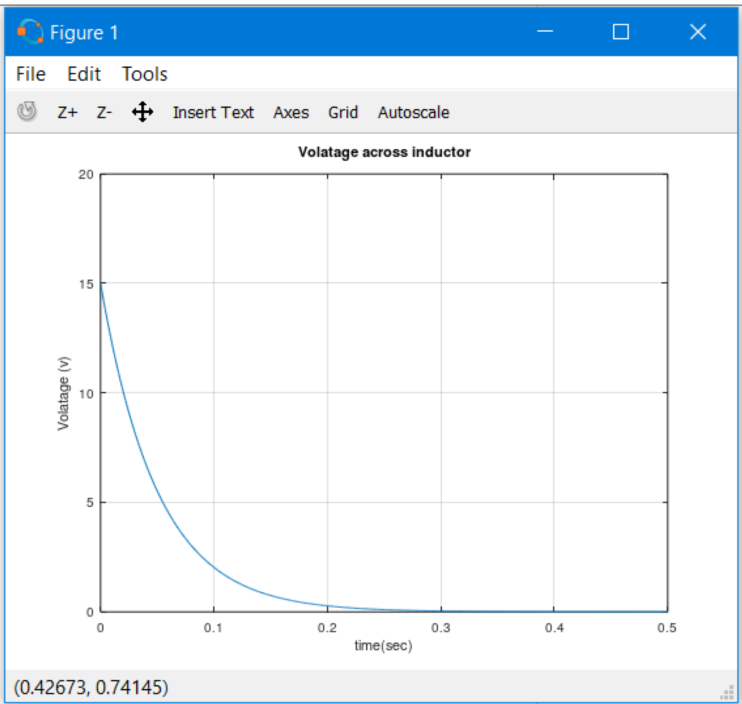
$V_L = 15 * e^0$

V_L = 15 v

Matlab:

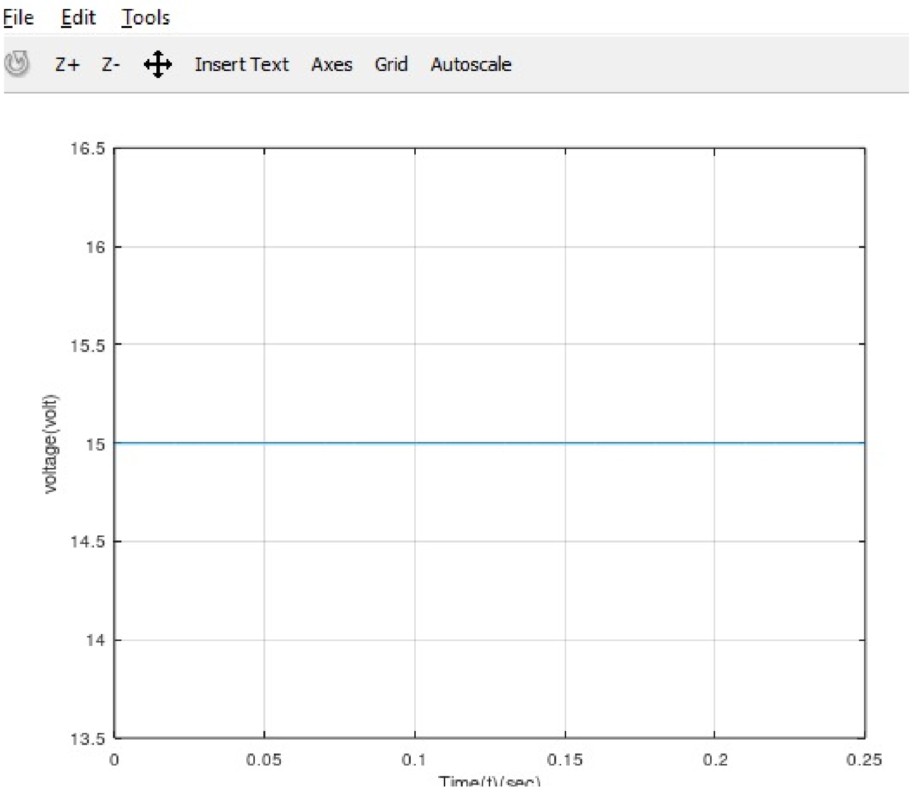
(voltage across inductor)

```
clc;
clear all;
close all;

R=100;
L=5;
Vb=15;
delt = 0.001;
time_constant = L/R;

T= 10*time_constant;
i(1)=0;

t=0:delt:T;

A=-R*t/L;

vl=Vb*exp(A);

plot(t,vl);
title('Volatage across inductor');
xlabel('time(sec)');
ylabel('Volatage (v)');
grid('on');
```



(voltage across resistor)

```
clc;
clear all;
close all;
Vb=15;
R=100;
T=0.25;
i=0.15;
delt=0.01;
L=5;
t=0:delt:T;
for n=1:(length(t)-1)
  i(n+1)=i(n)+(delt*(((-i(n)*R)+Vb)/L));
end
VR=i*R;
plot(t,VR);
grid('on');
xlabel('Time(t)(sec)');
ylabel('voltage(volt)');
```



5. The steady state of the circuit must be 10 times higher than the steady state obtained in Q.No.3. Determine the resistance R. What's the relation between the resistance and the steady state for the fixed inductance?

<u>Solution:</u>

$5\tau_3$ = steady state (3rd question)

$5\tau_5$ = steady state (3th question)

$5\tau_3$ = 0.25 s

10 * $5\tau_3 = 5\tau_5$

$\tau_5 = \frac{2.5}{5}$ = 0.5 s

R = $\frac{L}{\tau}$ => R = $\frac{5}{0.5}$

R = 10 Ω

L= Fixed ; 5τ = steady state

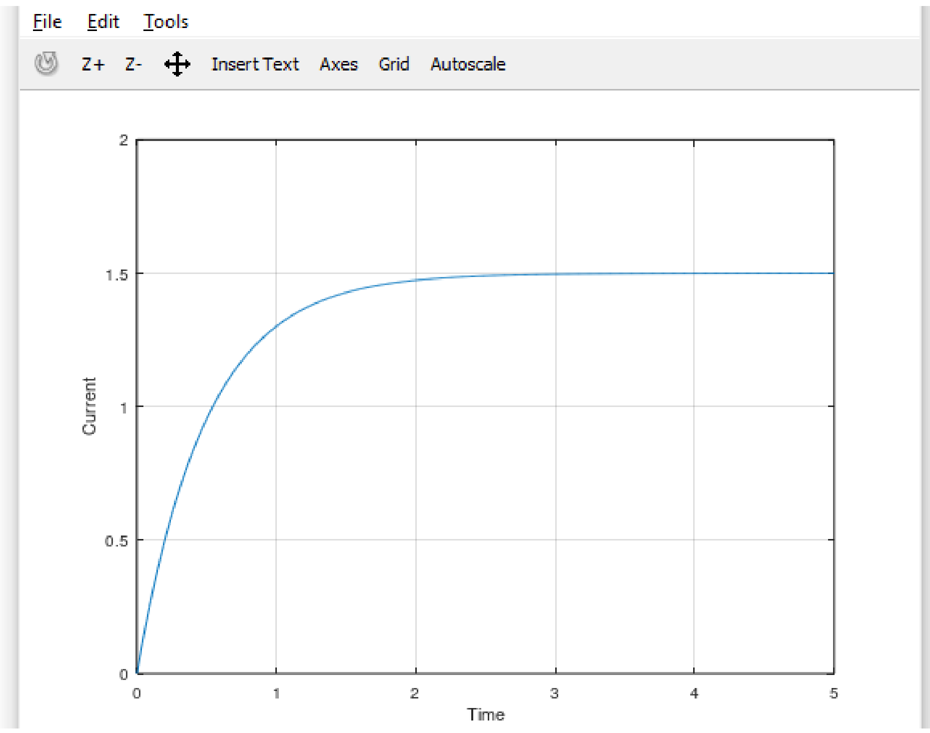
$5\tau = \frac{L}{R}$ => $5\tau \propto \frac{1}{R}$

Steady state is inversely proportional to resistance

<u>Matlab:</u>

.O_3.m

```
clc;
clear all;
close all;

Vb=15;
R=10;
L=5;
delt=0.01;
time_constant=L/R;
T=10*time_constant;

t=0:delt:T;

i(1)=0;

for n=1:(length(t)-1)
    i(n+1)=i(n)+(delt*(((-i(n)*R)+Vb)/L));
end

plot(t,i);
grid('on');
xlabel('Time');
ylabel('Current');
```



6. What is the maximum current in the circuit designed in Q.No.5. Plot the voltage across the resistor and the inductor.

Solution:

V_b= 15v; R= 10 Ω ; L = 5 H ; t=0 s

$I_{max}= \frac{Vb}{R}$

$R= \frac{L}{\tau} \Rightarrow \frac{5}{0.05} = 100\ \Omega$

$I_{max} = \frac{Vb}{R} \Rightarrow \frac{15}{10}$

I_{max} = 1.5 A

The maximum current is 0.15A.

$V_L= V_b * (e \wedge \frac{-Rt}{L})$

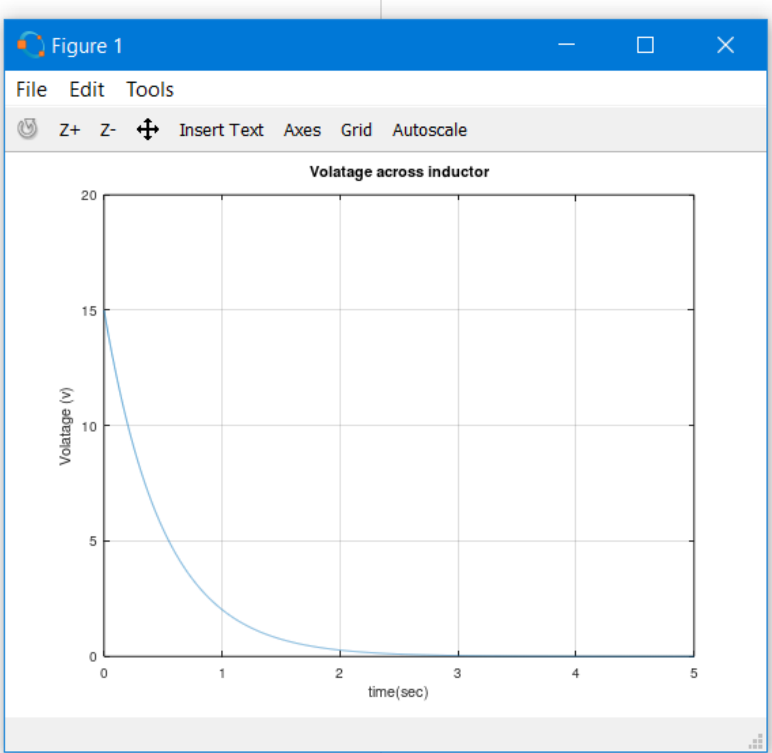
$V_L = 15 * (e \wedge \frac{-10*0}{5})$

$V_L = 15 * e^0$

$V_L = 15$ V

Matlab:(Voltage across inductor)

```
clc;
clear all;
close all;

R=10;
L=5;
Vb=15;
delt = 0.001;
time_constant = L/R;

T= 10*time_constant;

t=0:delt:T;

A=-R*t/L;
for n=1:(length(t)-1)
%i(n+1)= i(n)+(delt*(((-i(n)*R)+Vb)/L));
vl=Vb*exp(A);
end


plot(t,vl);
title('Volatage across inductor');
xlabel('time(sec)');
ylabel('Volatage (v)');
grid('on');
```



(Voltage across resistor)

```
clc;
clear all;
close all;

R=10;
L=5;
Vb=15;
delt = 0.001;
T=2;

i(1)=0;
t=0:delt:T;

for n=1:(length(t)-1)
i(n+1)= i(n)+(delt*(((-i(n)*R)+Vb)/L));
end
Vr= i*R;
Vl = Vb - Vr;
figure;
plot(t,Vl);
title('Voltage  across resistor');
xlabel('time(sec)');
ylabel('Voltage(v)');
grid('on');
```