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Drives, Controls and Modelling Laboratory Manual
(MTE 3161)

Fifth Semester B.Tech (Mechatronics Engineering)

NAME: SWARAJ DANGARE
REG NO: 210929156
ROLL NO: 37

Experiment I:

Date : 24 /8 /23

Introduction to Matlab

Aim:

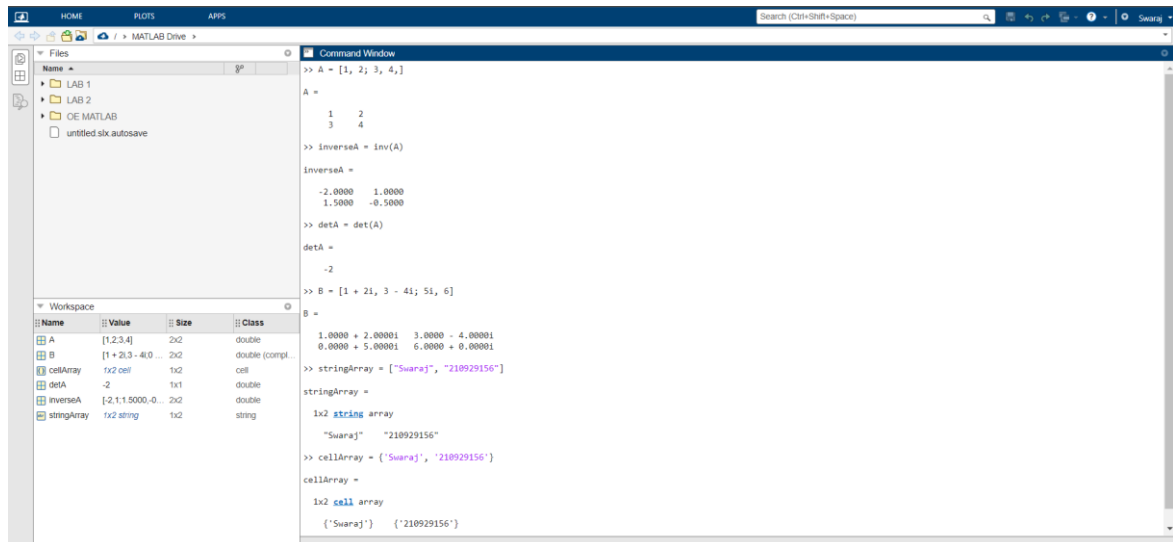
- To understand various simulation environments in Matlab.
- To develop the models for DC excited first order RL Circuit in various simulation environments.
- To develop RLC network in circuit approach in Matalab/Simulink

Matlab:

- MATLAB stands for MATrix LABoratory.**
- It is a software package for high-performance numerical computation and visualization.**
- It provides an interactive environment with hundreds of built-in functions for technical computation, graphical and animation.**

Problem1:

Matlab Matrix operations: creation of matrix, inv, det, complex matrix, string matrices, etc.



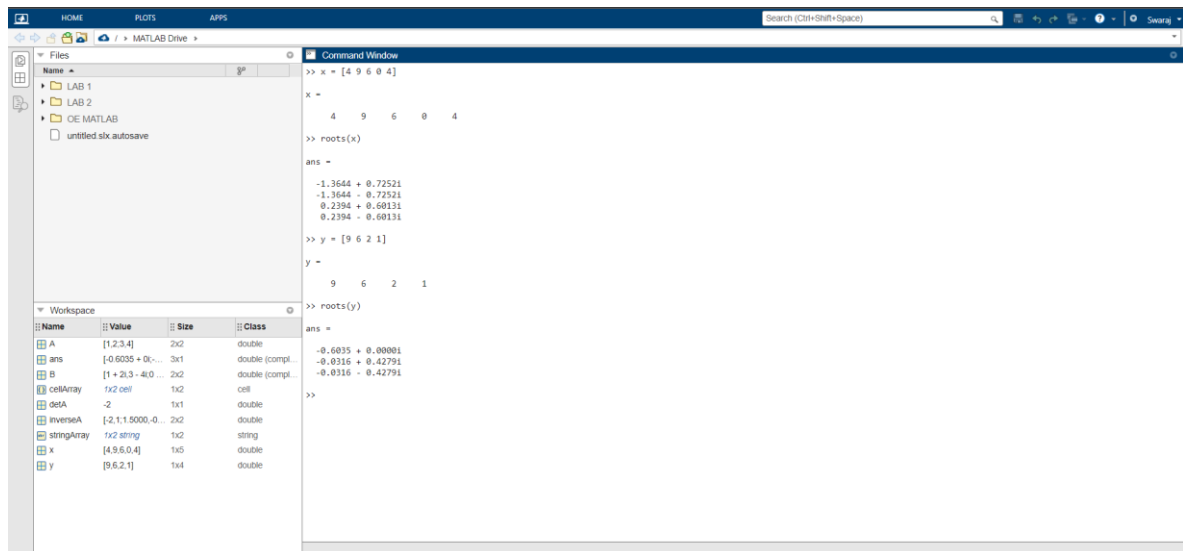
The screenshot displays the MATLAB interface with the Command Window and Workspace. The Command Window shows the following commands and outputs:

```
>> A = [1, 2; 3, 4];  
A =  
     1     2  
     3     4  
  
>> inverseA = inv(A)  
inverseA =  
    -2.0000    1.0000  
     1.5000    -0.5000  
  
>> detA = det(A)  
detA =  
     -2  
  
>> B = [1 + 2i, 3 - 4i; 5i, 6]  
B =  
    1.0000 + 2.0000i    3.0000 - 4.0000i  
    0.0000 + 5.0000i    6.0000 + 0.0000i  
  
>> stringArray = ["Swaraj", "210929156"]  
stringArray =  
    1x2 string array  
    "Swaraj"    "210929156"  
  
>> cellArray = {'Swaraj', '210929156'}  
cellArray =  
    1x2 cell array  
    {'Swaraj'}    {'210929156'}
```

The Workspace window shows the following variables:

Name	Value	Size	Class
A	[1,2,3,4]	2x2	double
B	[1 + 2i, 3 - 4i ...]	2x2	double (compl...)
cellArray	1x2 cell	1x2	cell
detA	-2	1x1	double
inverseA	[-2, 1; 1.5, -0.5]	2x2	double
stringArray	1x2 string	1x2	string

Mathematical operations: Solving general expressions and mathematical functions.



```

>> a=[1+2i 3+4i;5+1i 6+2i]

a =

    1.0000 + 2.0000i    3.0000 + 4.0000i
    5.0000 + 1.0000i    6.0000 + 2.0000i

>> b=[2+2i 6+2i; 7+3i 2+6i]

b =

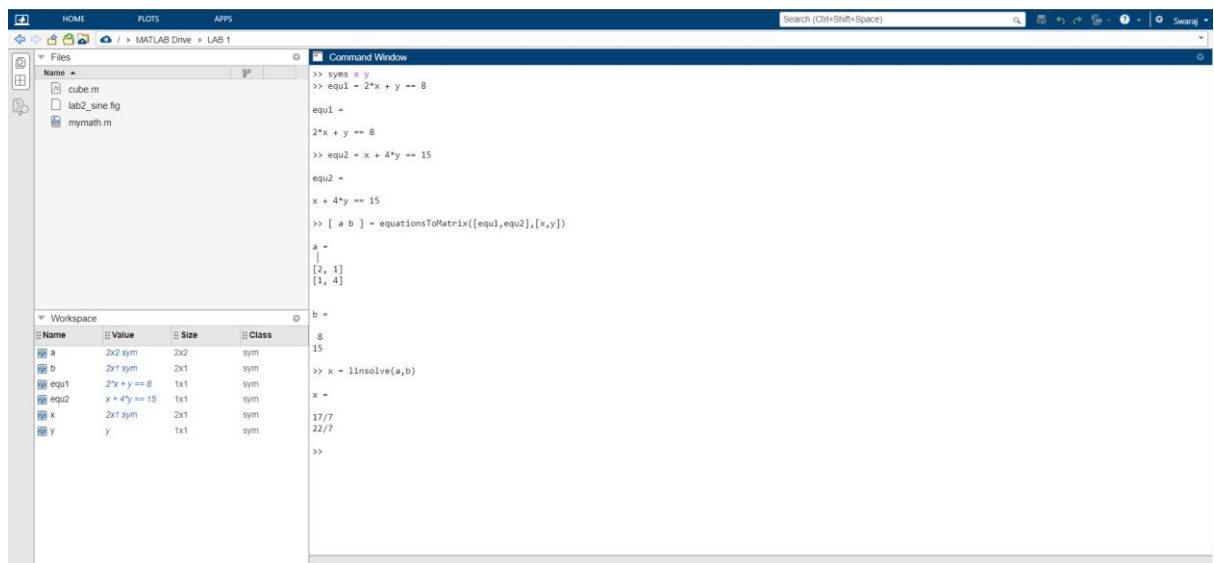
    2.0000 + 2.0000i    6.0000 + 2.0000i
    7.0000 + 3.0000i    2.0000 + 6.0000i

>> c= a * b

c =

    7.0000 +43.0000i   -16.0000 +40.0000i
   44.0000 +44.0000i   28.0000 +56.0000i

```



The MATLAB interface displays a system of three linear equations in three variables:

$$\begin{cases} x + 2y + z = 10 \\ 3x + y + 2z = 20 \\ x - 3y + 4z = 15 \end{cases}$$

The equations are defined in the Command Window as:

```

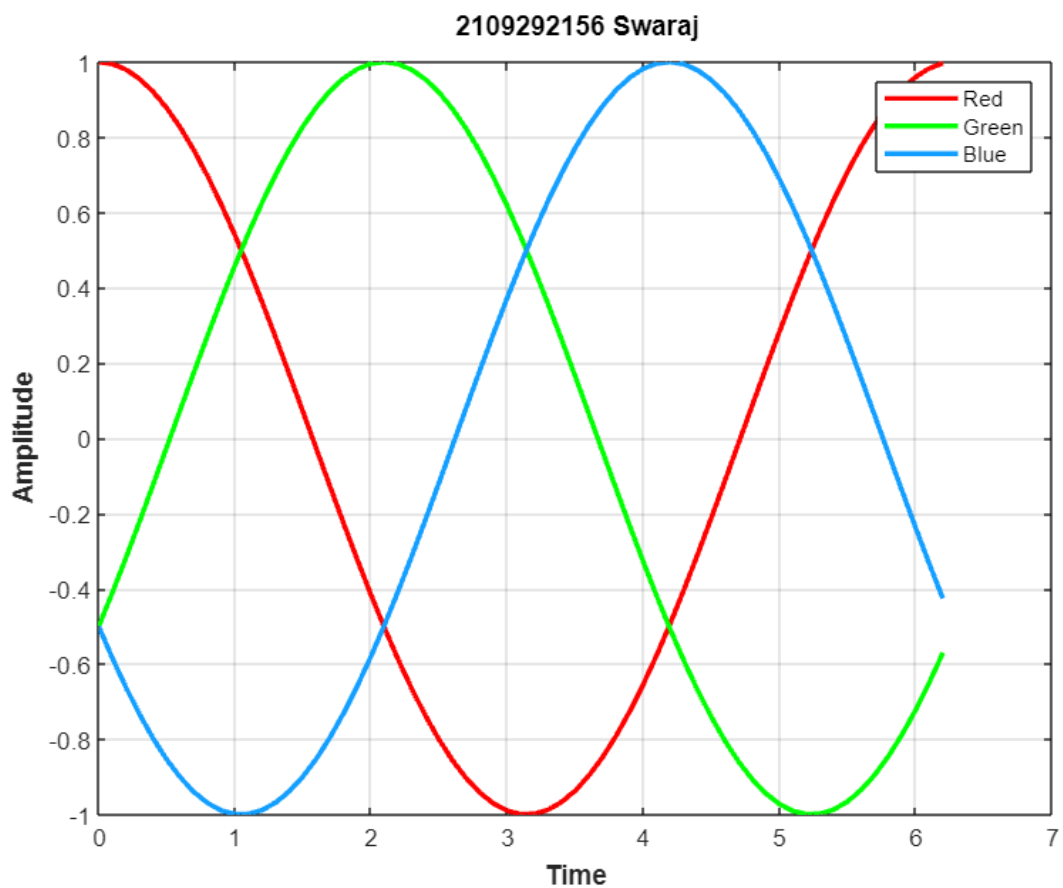
>> syms x y z
>> equ1 = x + 2*y + z == 10
equ1 =
x + 2*y + z == 10
>> equ2 = 3*x + y + 2*z == 20
equ2 =
3*x + y + 2*z == 20
>> equ3 = x - 3*y + 4*z == 15
equ3 =
x - 3*y + 4*z == 15
>> [ a b ] = equationsToMatrix([equ1,equ2,equ3],[x,y,z])
a =
[ 1, 2, 1]
[ 3, 1, 2]
[ 1, -3, 4]
b =
10
20
15
>> sol = linsolve(a,b)
sol =
15/4
5/4
15/4
>>

```

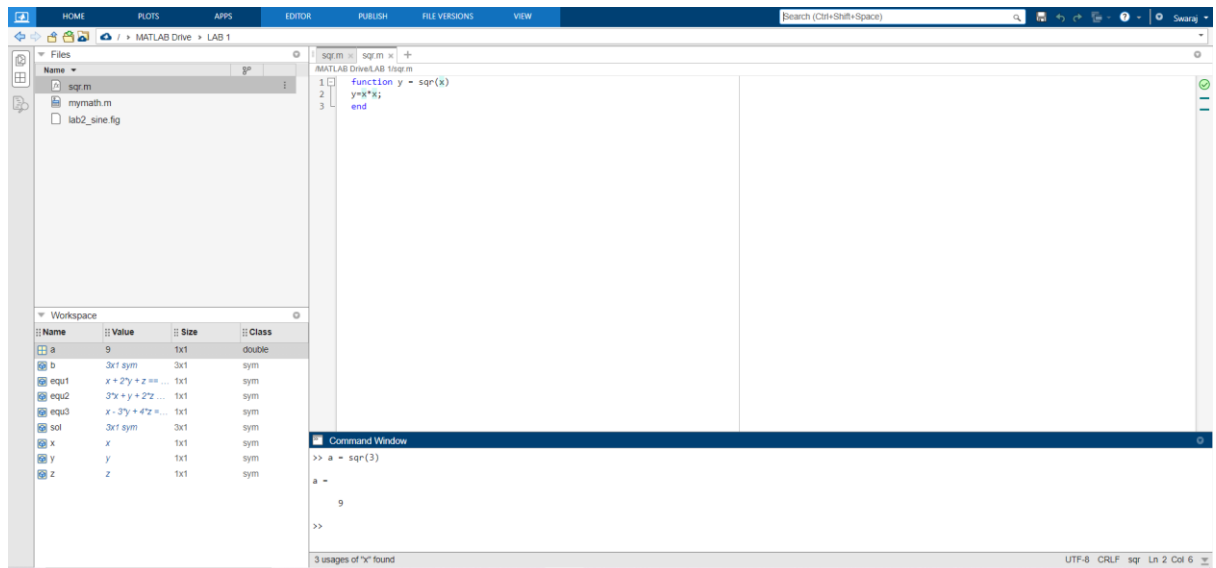
The Workspace window shows the variables defined:

Name	Value	Size	Class
a	3x3 sym	3x3	sym
b	3x1 sym	3x1	sym
equ1	$x + 2y + z == 10$	1x1	sym
equ2	$3x + y + 2z == 20$	1x1	sym
equ3	$x - 3y + 4z == 15$	1x1	sym
sol	3x1 sym	3x1	sym
x	x	1x1	sym
y	y	1x1	sym
z	z	1x1	sym

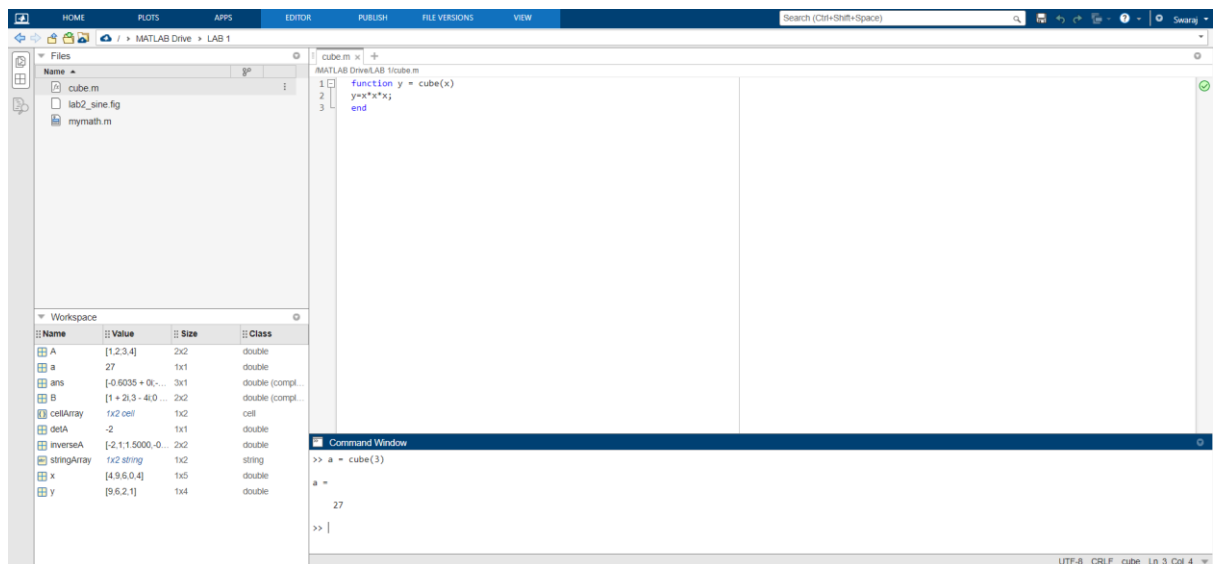
Graphics: plot instructions



Matlab Script: m file and editor.



Functions: creation and operation of functions.



Laplace transform operations: create transfer functions, step function etc

Simulink: various general Simulink block sets, **simscape**

Problem2:

Model the DC excited series RL circuit in following domains.

- Using direct expression for current in script.
- Using transfer function approach in script.
- Using Simulink block diagram approach mathematical & transfer function.
- Using Simulink simscape.

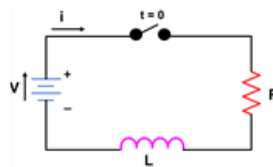
i. Analytical Expression in matlab script

Analytical Solution - Expression

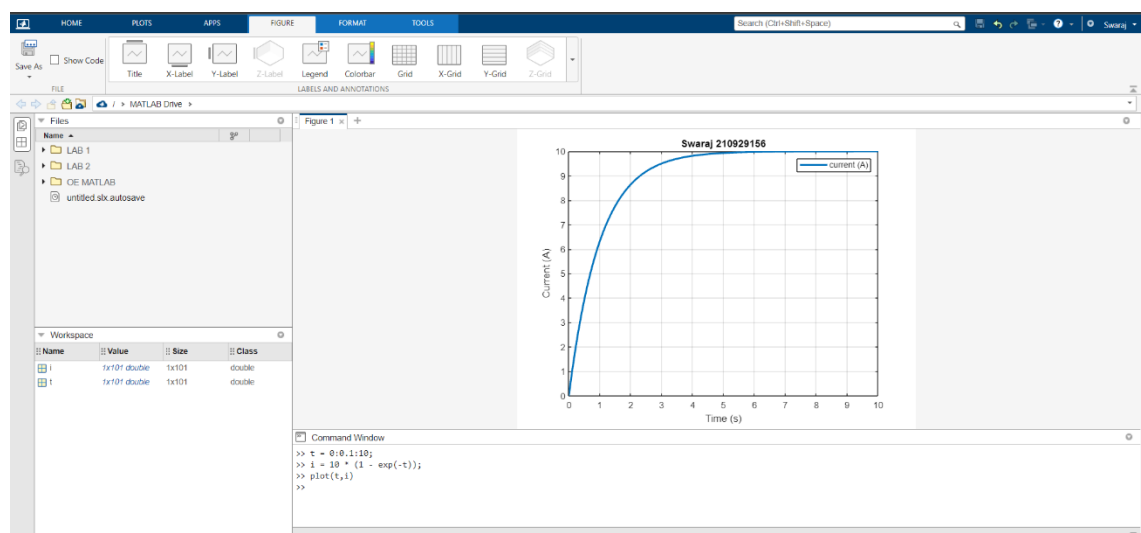
$$i = \left(\frac{V}{R}\right) \left(1 - e^{-\left(\frac{R}{L}\right)t}\right) \quad V = 10, R = 1, L = 1$$

$$i = (10) (1 - e^{-t})$$

```
>> t = 0:0.1:10;  
>> i = 10 * (1 - exp(-t));  
>> plot(t,i)
```



0:



ii.10*Using transfer function approach in script.

Using Laplace domain transfer function

$$V = R * i + L \frac{di}{dt} \quad \text{taking Laplace transform for this equation}$$

$$V(s) = R * I(s) + sL * I(s)$$

$$I(s) = \frac{V(s)}{R + sL} \quad \rightarrow \quad \text{transfer function } \frac{I(s)}{V(s)} = \frac{1}{R + sL} = \frac{1}{1 + s}$$

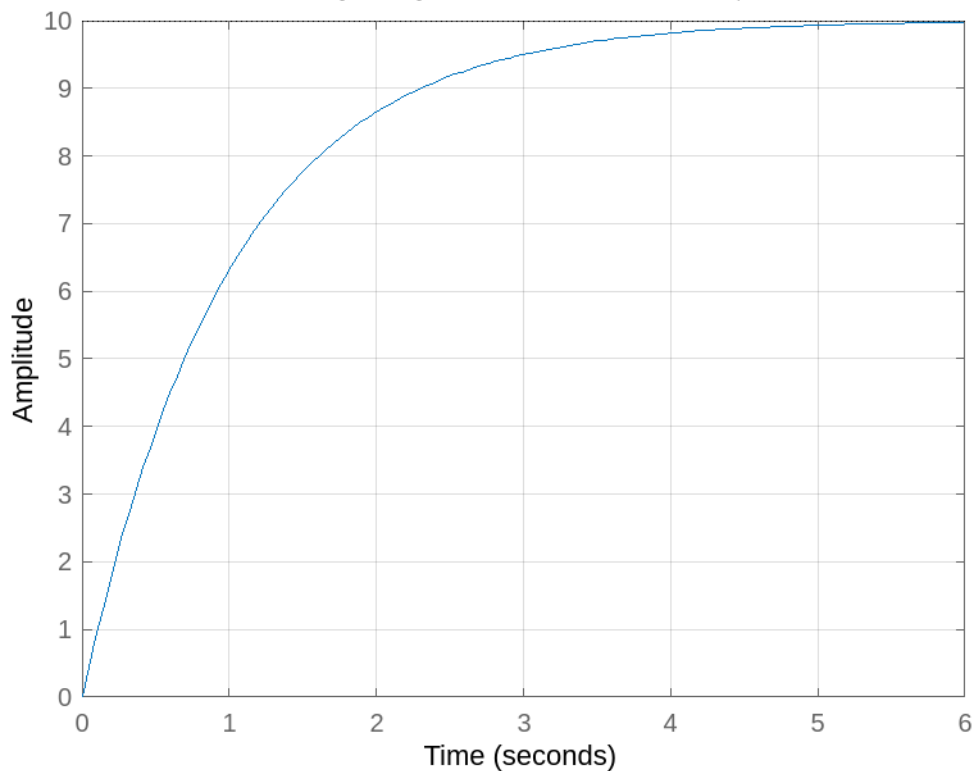
For given $V = 10, R = 1, L = 1$, the step response for the transfer function

» $s = tf('s')$; This is for transfer function variable 's'

» $G = 1/(s + 1)$; The transfer function

» $\text{step}(10 * G)$ 10 is for magnitude of Vdc applied

Step Response 210929156 Swara



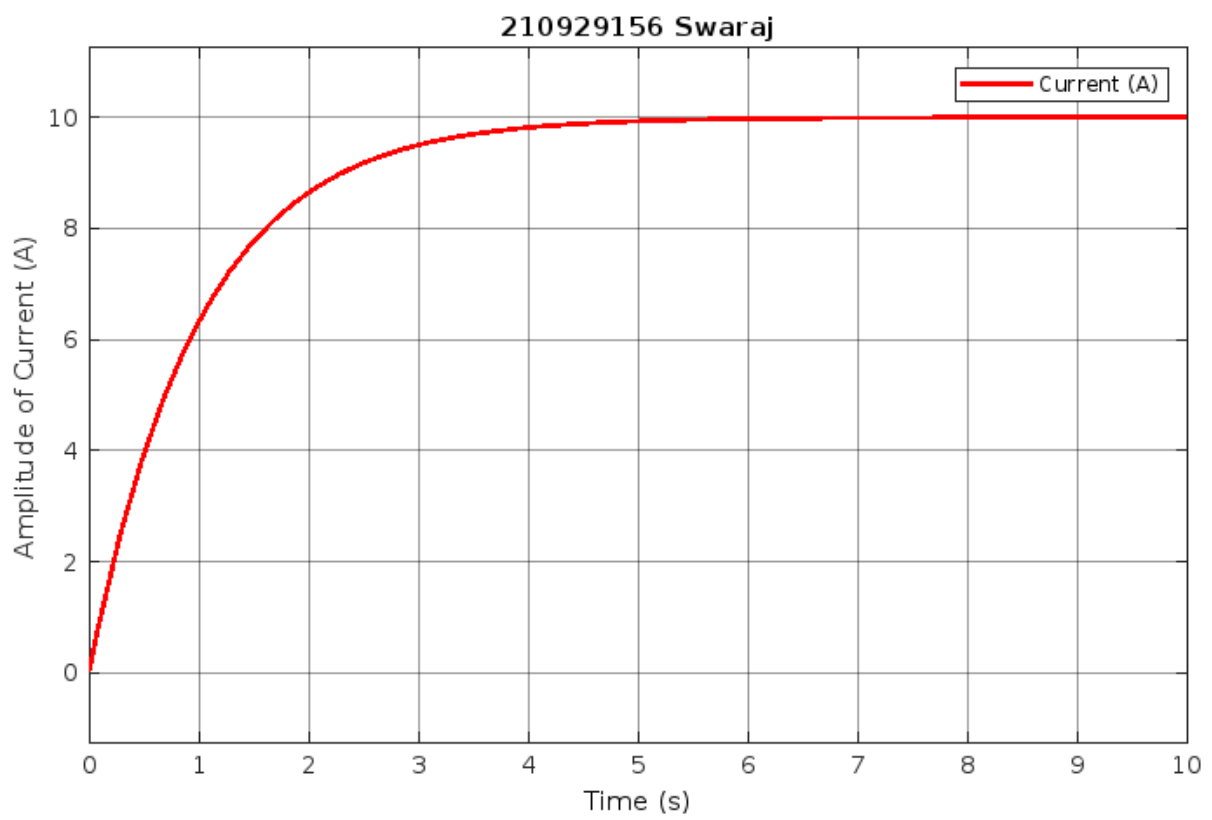
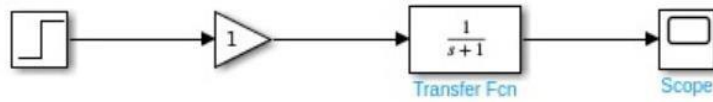
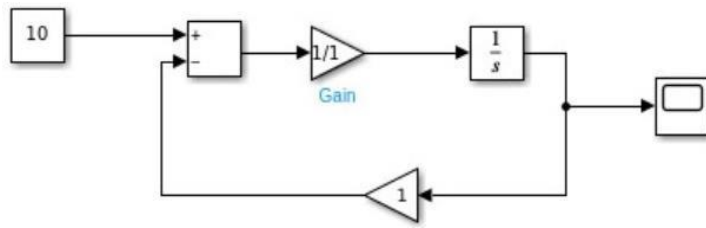
Using Simulink block diagram approach

$$V = R * i + L \frac{di}{dt} \quad \text{rearranging this equation for } di/dt$$

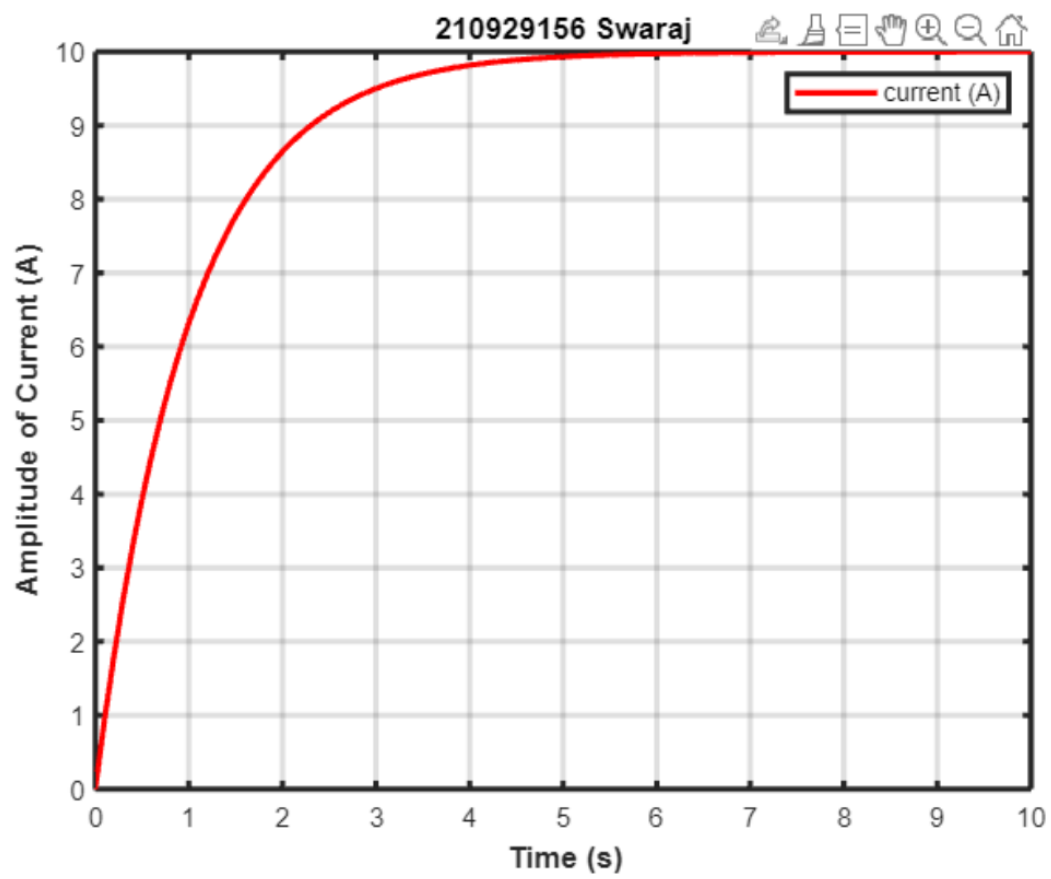
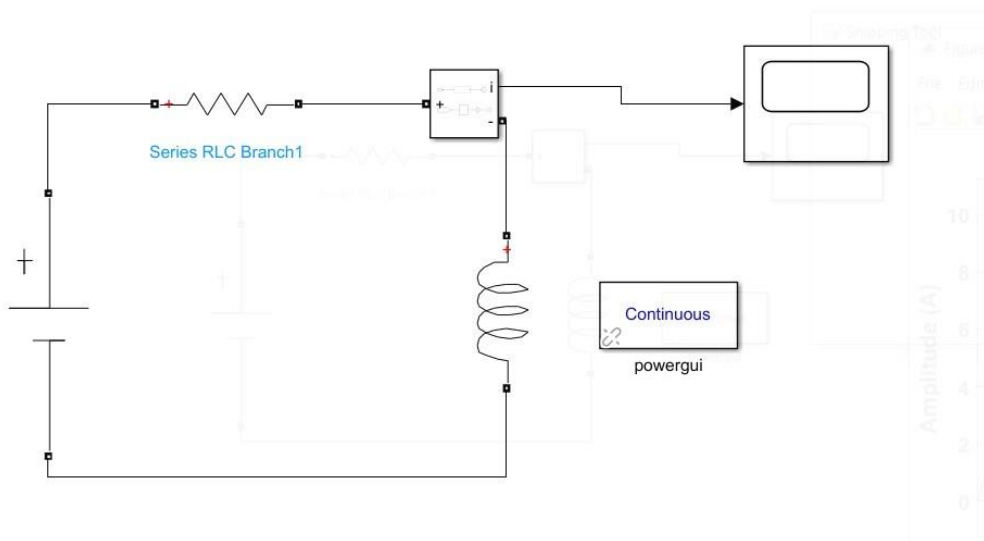
$$\frac{di}{dt} = \frac{V - R * i}{L} \quad \text{Integrating on both sides}$$

$$\int \frac{di}{dt} dt = \int (V - R * i) / L dt = i \quad \rightarrow \quad i * R$$





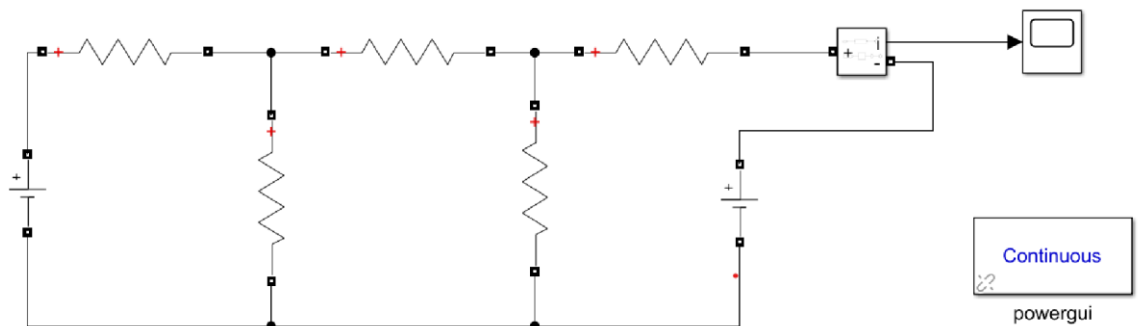
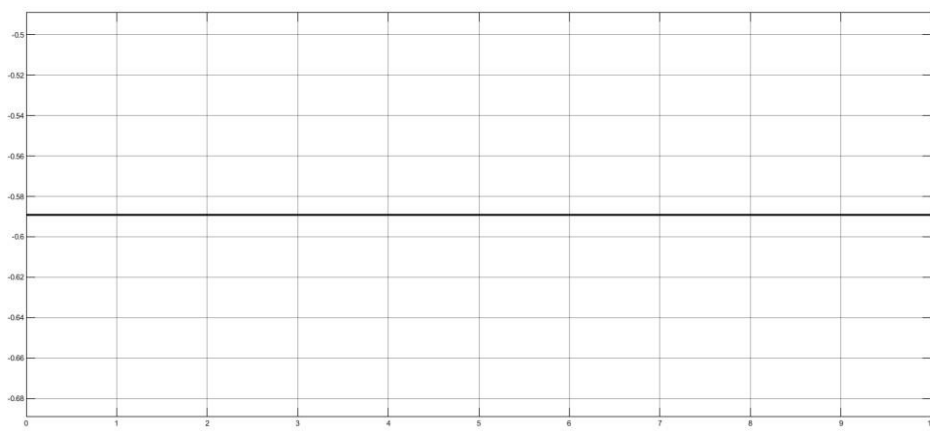
iv.Using Simulink simscape

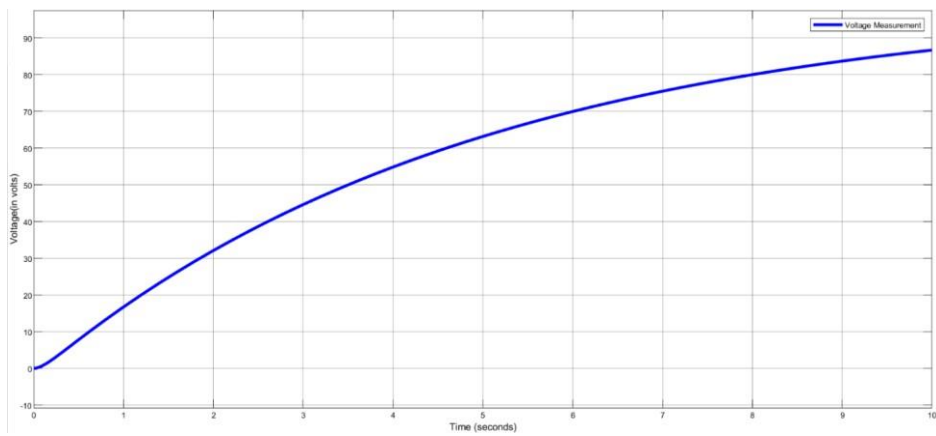
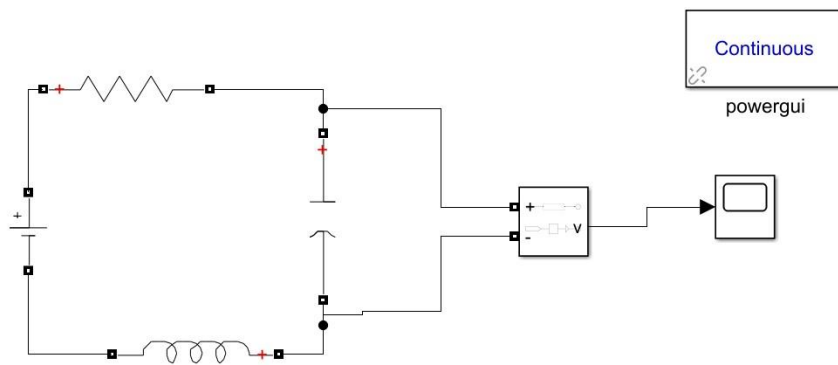


Open-Ended Lab Exercises - 1: (5M)

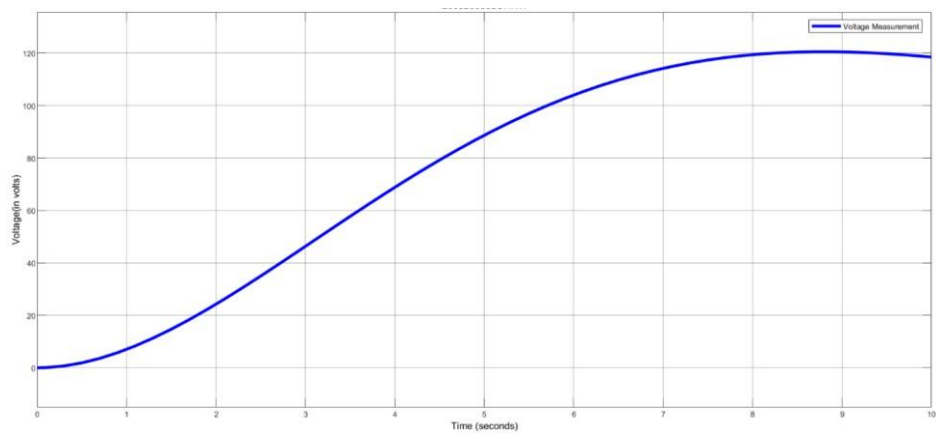
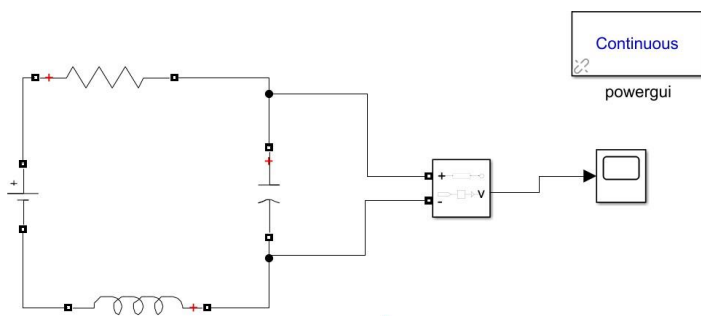
- Find the roots of equation $x^4 + 2x^3 + 2x + 1 = 0$.

```
>> a=[ 1 2 0 2 1];  
>> r=roots(a)  
  
r =  
  
-2.2966 + 0.0000i  
 0.3660 + 0.9306i  
 0.3660 - 0.9306i  
-0.4354 + 0.0000i
```





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5.

- Liquid level control in tanks can be modelled as first order systems.
- A linear spring-damper system.