EXPERMINT NO.1

BASIC COMMOND IN MATLAB

1.1 Introduction to MATLAB

MATLAB (matrix laboratory) is an engineering programming language that loads and represents data in the form of graphs or equations. There are most important features in MATLAB such as:

- A high-level language that is very sensitive to small and large case letters.
- It treats with inputs as one or two matrices.
- A language that reads line by line.
- Its best feature is the presence of a variable that receives numerical values that are not given to a specific variable.

1.2 MATLAB Interfaces

1.2.1 Command window

It is an interface or an executive screen for the Matlab program, in which we write all the instructions

1.2.2 Workspace

It is an interface that contains the variables, their value, and their location, and deals with them on a single or binary array

1.2.3 Command History

It is an interface that save all the commands that are read and written within the command window interface with date, day and hour

1.2.4 Commands

The commands used in this lab are:

Command	Specification
Close all	closes all open profiles without saving and deletes them from the workspace.
Clear all	removes all variables within the workspace interface
clc	clear everything within the command window
tf	Create tf objects representing continuous-time or discrete-time transfer functions in polynomial form.
zpk	representing continuous-time or discrete-time transfer functions in zero-pole-gain (factorized) form
residue	Convert between partial fraction expansion and polynomial coefficients.
sqrt	returns the square root of each element
abs	Absolute value and complex magnitude
laplace	returns the Laplace Transform of f. By default, the independent variable is t and the transformation variable is s.
ilaplace	returns the Inverse Laplace Transform of F. By default, the independent variable is s and the transformation variable is t.

1.3 Matrices :

Matrices are the fundamental representation of information and data in MATLAB.

- To create an array with multiple elements in a single row, separate the elements with either a comma ',' or a space. This type of array is called a row vector.

  A=[1 2 3 4 5 6]   OR   A=[1,2,3,4,5,6]

- To create an array with multiple elements in a single column, separate the elements with semicolons ';'. This type of array is called a column vector

  A=[1;2;3;4;5;6]

- To create a matrix that has multiple rows, separate the rows with semicolons.

  A=[1 2 3;4 5 6;7 8 9]

- To create an evenly spaced array, specify the start and end point by using the ':' operator.

  A=[a:x:b]

- Another way to create a matrix is to use a function, such as ones, zeros or rand.

A = zeros(a,b)

- Pull one or more elements from an array by:

1. Name array(Item location)
2. a variable= Name array(Item location)

- Finding the length of the vector

A=[1 2 3 4 5]
Length(A)

- Add an element to a vector:

A(element site)=[value]

- Add some elements to a vector

A(first value site: second value site)=[values]

- Replacing an element with an element within the vector

A(site element whose value exchanged)=value

- Delete an element from a vector

A(site element whose deleted)=[]

1.4 Transfer Function Representations

Control System Toolbox software supports transfer functions that are continuous-time or discrete-time, and SISO or MIMO. You can also have time delays in your transfer function representation.

A SISO continuous-time transfer function is expressed as the ratio:

$$G(s) = \frac{N(s)}{D(s)}$$

polynomials $N(s)$ and $D(s)$, called the numerator and denominator polynomials, respectively. You can represent linear systems as transfer functions in polynomial or factorized (zero-pole-gain) form;

$$G(S) = \frac{s^2 - 3s - 4}{s^2 + 5s + 6}$$

Example of creating TF Models

```
num = [1 0];
den = [1 3 2];
sys=tf (num,den)
```

Ex:1 find zero, poles and gain from this equation ;

$$\mathrm{H(s)} = \frac{4s^2 + 16s + 12}{s^4 + 12s^3 + 44s^2 + 48s}$$

Ans:

```
close all
clear all
clc

num=[0 0 4 16 12];
den=[1 12 44 48 0];
[z,p,k]=tf2zp(num,den)
```

Ex: create the following Transferfunction using tf(num,den)

$$\mathrm{H(s)} = \frac{s + 1}{s^2 + 3s + 1}$$

And then convert from TF model (polynomial form) to zpk model(factored form)

Ans.:

```
close all
```

```
clear all
clc

num=[1 1];

den= [1 3 1];

sys=tf(num,den)

[z,p,k]=tf2zp(num,den)
```

Ex: analyse the rational function T(s) as partial fraction

$$T(s) = \frac{s + 2}{s^3 + 4s^2 + 3s}$$

Ans:

```
num=[1 2];

den=[1 4 3 0];

[r p k]=residue (num,den)
```

Ex:find the rational function X(z) that corresponds to the following sum of partial fraction

$$X(z) = \frac{3}{z - 1} + \frac{1.5}{z + 4.3} + \frac{-1}{z - 2} + 2$$

Ans:

```
r =[3;1.5;-1];

p =[1;-4.3;2];

k =2;

[num,den]=residue(r,p,k)
```

Ex: find laplace transform of the function f(t)=3t

Ans:.

```
syms t;
f=3*t^1;
S=laplace(f)
Pretty(S)
```

Ex: find inverse laplace transform of the function

$$D(s) = \frac{3}{s^2}$$

Ans:.

```
syms s;
D=3/s^2;
f=ilaplace(D)
```

Ex: $Z=2xy^2 + x^2\sqrt{y} + 30$

$Y=\sin(x+3) - \tan|x|$,when x=2

Ans:.

```
x=2;
y=sin(x+3)-tan(abs(x));
z=2*x*y^2+x^2*sqrt(y)+3
```

Inverse laplace Transform

$$F(s) = \frac{N(s)}{D(s)} \Rightarrow N(s) = 0 \rightarrow \text{Zeros of } F(s)$$

$$D(s) = 0 \rightarrow \text{poles of } F(s)$$

Ex:- $F(s) = \dfrac{s^2+12}{s(s+2)(s+3)}$

by algebric method

$$\frac{s^2+12}{s(s+2)(s+3)} = \frac{A}{s} + \frac{B}{(s+2)} + \frac{C}{(s+3)}$$

$$s^2+12 = A(s+2)(s+3) + Bs(s+3) + Cs(s+2)$$

$$s^2+12 = A(s^2+5s+6) + B(s^2+3s) + C(s^2+2s)$$

Constant : $12 = A6 \rightarrow A = \frac{12}{6} = 2$

s^1 : $0 = 5A + 3B + 2C \rightarrow 3B + 2C = -10$

s^2 : $1 = A + B + C \rightarrow B + C = -1$

$\Rightarrow$ $\boxed{A = 2}$; $\boxed{B = -8}$; $\boxed{C = 7}$

$$\therefore F(s) = \frac{2}{s} - \frac{8}{(s+2)} + \frac{7}{(s+3)}$$

Taking inverse laplace

$$\therefore f(t) = \mathcal{L}^{-1} F(s) = \mathcal{L}^{-1} \frac{2}{s} + \mathcal{L}^{-1} \frac{-8}{s+2} + \mathcal{L}^{-1} \frac{7}{s+3}$$

$$f(t) = 2u(t) - 8e^{-2t}u(t) + 7e^{-3t}u(t)$$

$$= \left(2 - 8e^{-2t} + 7e^{-3t}\right)u(t)$$

HOMEWORKS

1. Find numerator and denominator and transfer function from this equation

$$\mathrm{H(S)} = \frac{S+1}{S^4+2S^3+4S^2+S+10}$$

2. Use zpk function to great Transfer function ,with sampling time 0.4

$$\mathrm{K(z)} = 2\frac{z+0.5}{(z+1)(z+2)}$$

3. Write Matlab code to produce the zero pole gain representation of the following transform function

$$\mathrm{G(s)} = \frac{(S-3)}{(5s^2+7S+9)}$$

4. Find laplace transform for this function f(t)=7exp(-3t)
5. Find inverse laplace transform for this function

$$\mathrm{H(s)} = \frac{5}{s^2+25}+\frac{s}{s^2+9}$$