Frequency Domain Modelling in MATLAB

LAB # 06

Fall 2024

CSE-310L Control Systems Lab

Submitted by: **Ali Asghar**

Registration No.: **21PWCSE2059**

Class Section: **C**

"On my honor, as student of University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work."

Submitted to:

Dr. Muniba Ashfaq

Date:

1st **December 2024**

Department of Computer Systems Engineering

University of Engineering and Technology, Peshawar

Objectives:

The objective of this lab is to learn about:

- finding the Laplace and Inverse Laplace transforms using MATLAB

5.1 Use the MATLAB and Control System Toolbox to form a linear time invariant system transfer function

$$\boldsymbol{F(s) = \frac{2}{(s+1)(s+2)^2}}$$

Code:

task5_1.m

```
F = zpk([],[-1 -2 -2],2)
```

Output:

F

1x1 zpk

Property	Value
Z	1x1 cell
P	1x1 cell
K	2
DisplayFor...	'roots'
Variable	's'
IODelay	0
InputDelay	0
OutputDel...	0
InputName	1x1 cell
InputUnit	1x1 cell
InputGroup	1x1 struct
OutputNa...	1x1 cell
OutputUnit	1x1 cell
OutputGro...	1x1 struct
Notes	0x1 string
UserData	[]
Name	''
Ts	0
TimeUnit	'seconds'
Sampling...	1x1 struct

5.2 Use the MATLAB to get the equation

$$f(t) = 2e^{-t} - 2te^{-2t} - 2e^{-2t}$$

Task 8:

Code:

```
syms a
syms t

f = 2*exp(-t) - 2*t*exp(-2*t)- 2*exp(-2*t);

l = laplace(f);
pretty(l)
```

Output:

```
>> task8
  2        2          2
----- - ----- - --------
s + 1   s + 2          2
                (s + 2)

>>
```

5.3 Use the MATLAB and Control System Toolbox to form a linear time invariant system transfer function

$$F(s) = \frac{3}{s(s^2 + 2s + 5)}$$

Code:

```
1     F = tf([3],[1 2 5 0])
```

Output:

F

1x1 tf

Property	Value
Numerator	1x1 cell
Denomina...	1x1 cell
Variable	's'
IODelay	0
InputDelay	0
OutputDel...	0
InputName	1x1 cell
InputUnit	1x1 cell
InputGroup	1x1 struct
OutputNa...	1x1 cell
OutputUnit	1x1 cell
OutputGro...	1x1 struct
Notes	0x1 string

5.4 Use the MATLAB to find the inverse laplace transform of the system transfer function

$$F(s) = \frac{3}{s(s^2 + 2s + 5)}$$

Code:

task1.m | task2.m | task3.m | task4.m | task5.m | task6.m | task7.m | task8

```
syms s

f = ilaplace(3/(s*(s^2 + 2*s + 5)));
pretty(f)

```

Output:

```
>> task1
              /               sin(2 t) \
    exp(-t) | cos(2 t) + -------- | 3
3             \                  2     /
- - --------------------------------
5                    5
```

5.5 Use MATLAB to get the following equation

$$F(s) = \frac{3/5}{s} - \frac{3}{20}\left(\frac{2+j1}{s+1+j2} + \frac{2-j1}{s+1-j2}\right)$$

Code:

▸ 7thSemester ▸ Control Systems - Lab ▸ ControlSystemLab6 ▸ MATLAB

Editor - D:\GitHUb\UET_CSE_DataPack4\7thSemester\Control Systems - Lab\ControlSystemLab6\MATLAB\task5_5.m

task5_5.m | task1.m

```
numf=3;
denf=[1 2 5 0];
[k,p,k] = residue(numf,denf);

syms s

f = ilaplace((3/5)/s - 3/20*((2+1j) / (s+1+2j) + (2-2j) / (s+1-2j) ));
pretty(f)
```

Output:

Command Window

New to MATLAB? See resources for Getting Started.

```
>> task5_5
3                     /   3    3  \                          /   3    3  \
- + exp(t (- 1 + 2i)) | - -- + --i | + exp(t (- 1 - 2i)) | - -- - --i |
5                     \   10   10 /                          \   10   20 /
```

5.6 Use the MATLAB to find the inverse laplace transform of the system transfer function

$$C(s) = R(s)G(s) = \frac{1}{s(s+2)}$$

Code:

task1.m | task2.m | task3.m | task4.m | task5.m | task6.m

```
syms s

f = ilaplace(1/(s*(s + 2)));
pretty(f)
```

Output:

```
>> task2
1    exp(-2 t)
- - ---------
2        2
```

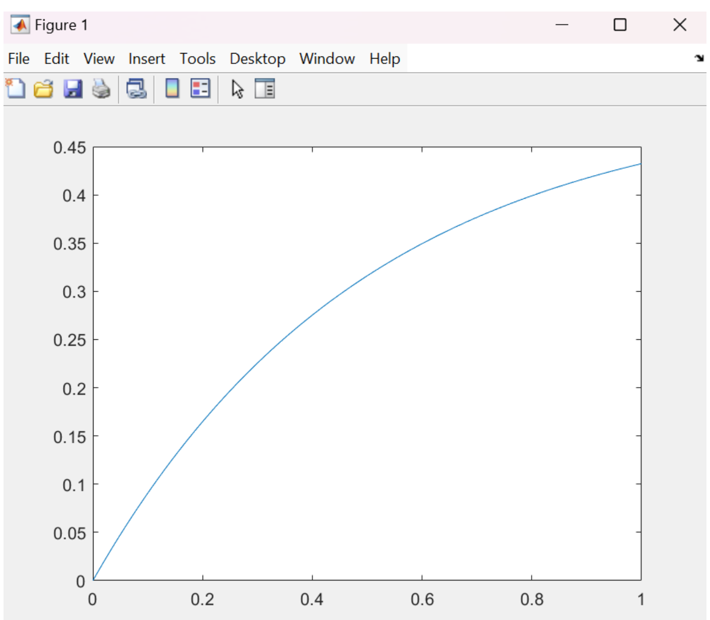
5.7 Use MATLAB to plot the following function for t from 0 to 1 with the intervals of 0.01

$$c(t) = \frac{1}{2} - \frac{1}{2}e^{-2t}$$

Code:

```
task5_7.m
t = 0:0.01:1;
plot(t,(1/2-1/2 *exp(-2*t)))
```

Output:



5.8 Use MATLAB and Symbolic Math Toolbox to help you solve the following equation for currents.

$$+(2s+2)I_1(s) - (2s+1)I_2(s) - I_3(s) = V(s)$$

$$-(2s+1)I_1(s) - (9s+1)I_2(s) - 4sI_3(s) = 0$$

$$-I_1(s) - 4sI_2(s) + (4s+1+\frac{1}{s})I_3(s) = 0$$

Code:

task1.m task2.m task3.m task4.m task5.m task6.m task7.m task8.m task9.m task10.m

```
syms s V I1 I2 I3

A = [[2*s+2 -2*s-1 -1],
     [-2*s-1 9*s+1 -4*s],
     [-1 -4*s 4*s+1+1/s]];

B = [I1; I2; I3;];
C = [V; 0; 0;];
B = inv(A)*C;
pretty(B)
```

Output:

```
>> task10
/        3       2              \
| V (20 s  + 13 s  + 10 s + 1) |
| ---------------------------- |
|              #1              |
|                              |
|        3       2             |
|  V (8 s  + 10 s  + 3 s + 1)  |
|  --------------------------  |
|              #1              |
|                              |
|              2               |
|     V s (8 s  + 13 s + 1)    |
|     ---------------------    |
\              #1              /

where

            4       3       2
   #1 == 24 s  + 30 s  + 17 s  + 16 s + 1
```

Lab Tasks:

Task 1:

Code:

task1.m task2.m task3.m task4.m task5.m

```
syms s

f = ilaplace(1/s^2);
pretty(f)
```

Output:

```
>> task3
t
```

Task 2:

Code:

task2.m task3.m task4.m task5.m task6.m

```
syms s
syms a

f = ilaplace(1/(s-a)^2);
pretty(f)
```

Output:

```
>> task4
t exp(a t)
```

Task 3:

Code:

```
syms f
syms t

f = t;
l = laplace(f);
pretty(l)
```

Output:

```
>> task5
 1
--
 2
s
```

Task 4:

Code:

```
syms a
syms t

f = cos(a*t)

l = laplace(f)
pretty(l)
```

Output:

```
>> task6
   s
-------
 2     2
a   + s

>>
```

Task 5:

Code:

task2.m task3.m task4.m task5.m task6.m task7.m

```
syms a
syms t

f = 1 + 2*exp(-t) + 3*exp(-2*t);

l = laplace(f)
pretty(l)
```

Output:

```
>> task7
  2        3      1
----- + ----- + -
s + 1   s + 2   s

>>
```

Task 6:

Code:

task1.m task2.m task3.m task4.m task5.m task6.m task7.m task8.m task9.m task

```
syms s
num = [0 0 4 4 4];
denum = [1 3 2 0 0];

[r, p, k ] = residue(num, denum);

F1 = r(1)/(s-p(1));
F2 = r(2)/(s-p(2));
F3 = r(3)/(s-p(3));
F4 = r(4)/(s-p(4));

pretty(F1);
pretty(F2);
pretty(F3);
pretty(F4);
```

```
pretty(F1);
pretty(F2);
pretty(F3);
pretty(F4);

l1 = ilaplace(F1);
l2 = ilaplace(F2);
l3 = ilaplace(F3);
l4 = ilaplace(F4);

pretty(l1)
pretty(l2)
pretty(l3)
pretty(l4)
```

Output:

```
>> task9
    3
- -----
  s + 2

  4
-----
s + 1

  1
- -
  s

2
-
s

-exp(-2 t) 3

4 exp(-t)

-1

2
```