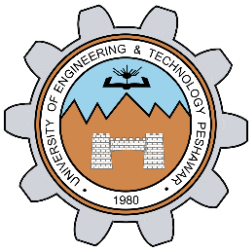
Time Domain Modelling in MATLAB

LAB # 07



Fall 2024

CSE-310L Control Systems Lab

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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**

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Objectives:

The objective of this lab is to:

- model the system in time domain.

State Space Representation:

State Space representation is one of the unified method for modeling, analyzing and designing a wide range of systems.

6.1 Use the MATLAB code to form an LTI state space representation from the transfer function. The matrix A, B and C are shown below.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -24 & -26 & -9 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

$$y = [b_0 \quad b_1 \quad b_2] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = [2 \quad 7 \quad 1] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Code:

Editor - D:\GitHUb\UET_CSE_DataPack4\7thSemester\Control Systems - Lab\ControlSystemLab7\Task1.m

Tasks.m | Task1.m | Task2.m | Task3.m | Task4.m | Task5.m | Task6.m

```
A=[0 1 0;
   0 0 1;
  -24 -26 -9];

B = [0; 0; 1];
C = [2 7 1];
D = 0;
[Num, Den]=ss2tf(A,B,C,D);
display(Num)
display(Den)
```

Output:

Command Window

New to MATLAB? See resources for Getting Started.

```
Num =

         0    1.0000    7.0000    2.0000


Den =

    1.0000    9.0000   26.0000   24.0000

fx >>
```

6.2 Use the MATLAB to convert the state space representation to the transfer function for the following

$$\mathbf{x} = \begin{bmatrix} -4 & -1.5 \\ 4 & 0 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 2 \\ 0 \end{bmatrix}u(t)$$

$$y = [1.5 \quad 0.625]\mathbf{x}$$

Code:

Tasks.m | Task1.m | Task2.m | Task3.m | Task4.m | Task5.m

```
clc;
clear all;
A=[-4 -1.5;
    4 0];
B=[2;0];
C=[1.5 0.625];
D=0;
[Num, Den]=ss2tf(A,B,C,D);
display(Num)
display(Den)
```

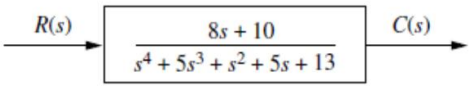
Output:

Command Window

New to MATLAB? See resources for Getting Started.

```
Num =

          0    3.0000    5.0000


Den =

     1     4     6

fx >>
```

6.3 Write the MATLAB code for the conversion of transfer function to the state space representation of the following system



Code:

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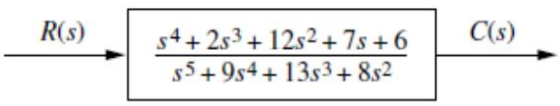
Tasks.m | Task1.m | Task2.m | Task3.m | Task4.m | Task5

```
1  num3=[0 0 0 0 8 10];
2  denum3=[1 5 1 5 13];
3  [A3,B3,C3,D3] = tf2ss(num3,denum3);
4  display(A3)
5  display(B3)
6  display(C3)
7  display(D3)
```

Output:

```
>> Task3

A3 =

    -5    -1    -5   -13
     1     0     0     0
     0     1     0     0
     0     0     1     0


B3 =

     1
     0
     0
     0


C3 =

     0     0     8    10


D3 =
```

6.4 Write the MATLAB code for the conversion of transfer function to the state space representation of the following system



Code:

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Tasks.m | Task1.m | Task2.m | Task3.m | Task4.m | Task5.m

```
num4=[0 1 2 12 7 6];
denum4=[1 9 13 8 0 0];
[A4,B4,C4,D4] = tf2ss(num4,denum4);
display(A4)
display(B4)
display(C4)
display(D4)
```

Output:

Command Window

New to MATLAB? See resources for Getting Started.

```
>> Task4

A4 =

    -9   -13    -8     0     0
     1     0     0     0     0
     0     1     0     0     0
     0     0     1     0     0
     0     0     0     1     0


B4 =

     1
     0
     0
     0
     0


C4 =

     1     2    12     7     6
```

fx

6.5 Write the MATLAB code for the conversion of state space representation to the transfer function for the following

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 & 5 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -7 & -9 & -2 & -3 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 0 \\ 5 \\ 8 \\ 2 \end{bmatrix} r$$

$$y = [1 \quad 3 \quad 6 \quad 6]\mathbf{x}$$

Code:

Tasks.m | Task1.m | Task2.m | Task3.m | Task4.m | Task5.m

```
A = [0 1 5 0;
     0 0 1 0;
     0 0 0 1;
     -7 -9 -2 -3];
B = [0; 5; 8; 2];
C = [1 3 6 6];
D = 0;
[Num, Den]=ss2tf(A,B,C,D);
display(Num)
display(Den)
```

Output:

```
>> Task5

Num =

   1.0e+03 *

         0    0.0750   -0.0960   -2.3310   -0.2100


Den =

    1.0000    3.0000    2.0000   44.0000    7.0000

>>
```

6 .6 Write the MATLAB code for the conversion of state space representation to the transfer function for the following

$$\dot{\mathbf{x}} = \begin{bmatrix} 3 & 1 & 0 & 4 & -2 \\ -3 & 5 & -5 & 2 & -1 \\ 0 & 1 & -1 & 2 & 8 \\ -7 & 6 & -3 & -4 & 0 \\ -6 & 0 & 4 & -3 & 1 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 2 \\ 7 \\ 8 \\ 5 \\ 4 \end{bmatrix} r$$

$$y = [1 \quad -2 \quad -9 \quad 7 \quad 6]\mathbf{x}$$

Code:

Editor - D:\GitHUb\UET_CSE_DataPack4\7thSemester\Control Systems - Lab\ControlSystemLab7\Task6.m

Tasks.m | Task1.m | Task2.m | Task3.m | Task4.m | Task5.m | Task6.m

```
A = [3 1 0 4 -2;
     -3 5 -5 2 -1;
     0 1 -1 2 8;
     -7 6 -3 -4 0;
     -6 0 4 -3 1];
B = [2 7 8 5 4]';
C = [1 -2 -9 7 6];
D = 0;
[Num, Den]=ss2tf(A,B,C,D);
display(Num)
display(Den)
```

Output:

```
>> Task6

Num =

   1.0e+04 *

         0   -0.0025   -0.0292    0.1680    1.6282    3.1875


Den =

   1.0e+03 *

    0.0010   -0.0040   -0.0320    0.1480   -1.1530   -4.4800

>>
```