Lab # 2

Find Impulse Response, Step Response and Ramp Response Of A Transfer Function

Objective:

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Step Signal:

A step signal is a signal whose value changes from one level to another level in zero time. Mathematically, the step signal is represented as given below:

$r(t) = u(t)$, where

$u(t) = 1; t > 0$

$= 0; t < 0$

In the Laplace transform form,

$R(s) = \frac{1}{s}$

Command Used In Matlab:

- step(num,den)

Procedure:

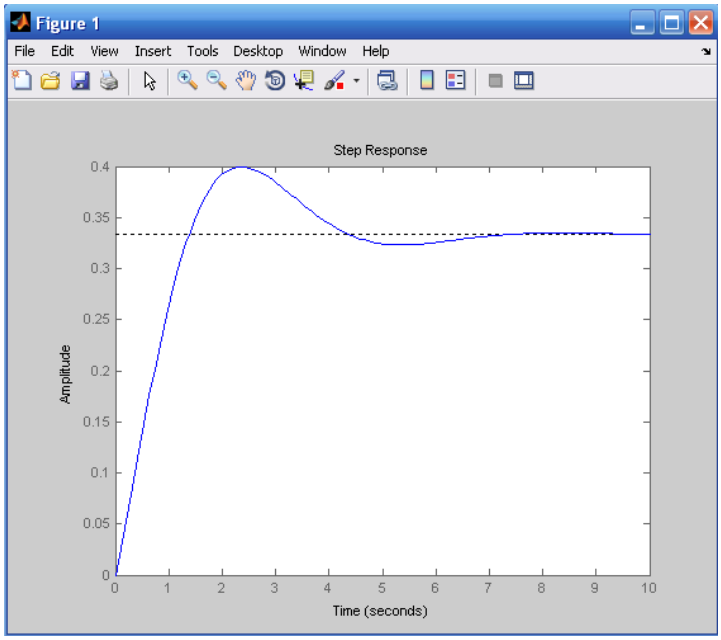
- Type the program in MATLAB editor that is in M-file.
- Give the required inputs in the command window of MATLAB in matrix format.
- 'step' function calculates the unit step response of a linear system.
- Zero initial state is assumed in state-space case.
- This model can be continuous or discrete, and SISO or MIMO.
- The step response of multi-input systems is the collection of step responses for each input channel.
- The duration of simulation is determined automatically based on the system poles and zeroes.

Example:

$$\frac{s+2}{4s^2+5s+6}$$

Code in Matlab :

```
num=[1 2]
den=[ 4 5 6]
tf(num,den)
step(num,den)
```



Impulse Response:

An impulse signal is a signal whose value changes from zero to infinity in zero time. Mathematically, the unit impulse signal is represented as given below:

$r(t) = \delta(t)$,

where:

$\delta(t) = 1; t = 0$

$= 0; t \neq 0$

In the Laplace transform form,

$R(s) = 1$

Command Used In Matlab:

impulse(num,den)

Procedure:

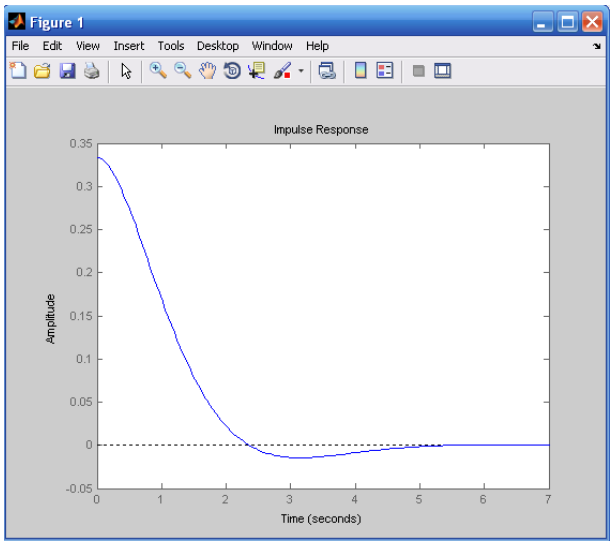
- Type the program in the MATLAB editor that is in M-file.
- Save and run the program.
- Give the required inputs in the command window of MATLAB in matrix format.
- 'impulse' calculates the impulse response of a linear system.
- The impulse response is the response to the Dirac input, δ (t) for continuous time systemsand to a unit pulse at for discrete time systems.
- Zero initial state is assumed in the state space case.
- This model can be continuous or discrete, SISO or MIMO.
- The impulse response of multi-input systems is the collection of impulse responses foreach input channel.
- The duration of simulation is determined automatically to display the transient behaviorof the response.
- Note down the response of the given transfer function obtained in MATLAB.
- The response of the transfer function

Example 2:

$$\frac{s+2}{3s^2+6s+6}$$

Code in Matlab :

```
num=[1 2]
den=[36 6]
tf(num,den)
impulse(num,den)
```



Ramp Response:

A ramp signal is a signal which changes with time gradually in a linear fashion. Mathematically, the unit ramp signal is represented as given below:

$$r(t) = t; t > 0$$

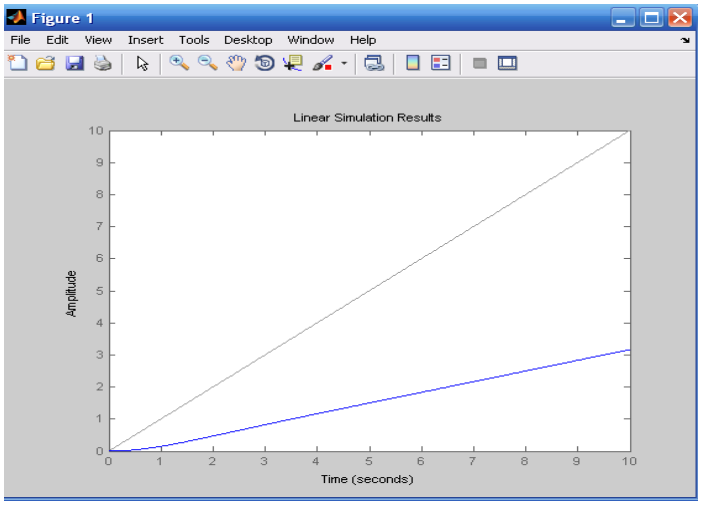
$$= 0; t < 0$$

In the Laplace transform form,

$$R(s) = \frac{1}{s^2}$$

Command Used In Matlab:

```
t=0:0.01:10;
u=t;
num = input('enter the numerator of the transfer function')
den = input('enter the denominator of the transfer function')
lsim(num,den,u,t)
```



Post Lab Questions

a) Fill the following table:

S.No	Name	Definition	Command Used
1	Step Signal		
2	RampSignal		
3	Impulse Signal		
4	Transfer Function		

Lab Tasks

Task 1

a) Find the step response and impulse response of the following transfer function:

1.

$$H(s) = \frac{y(s)}{u(s)} = \frac{2}{4s + 1}$$

2.

$$H(s) = \frac{y(s)}{u(s)} = \frac{2s + 3}{s^2 + 4s + 3}$$

Task 2

Given the following :

Numerator=[2 3]
Denominator=[1 4 3 7]

i) Find the transfer function
ii) Find the zeros, poles and gain.
iii) Find the step response of the signal
iv) Find the impulse response.

Task 3

Find the Ramp response of the following:

$$\frac{C(s)}{R(s)} = \frac{s^2 + 4s + 3}{s^3 + 3s^2 + 7s + 5}$$