Tutorial 5

Dr. Mukta Bansal

School of Chemistry, Chemical Engineering & Biotechnology (CCEB)

Office: N1.2 – B2 – 28

Email: mbansal@ntu.edu.sg

Learning Objectives

At the end of this tutorial, you should be able to:

- Write Transfer Functions in Matlab
- Distinguish between step response and impulse response
- Obtain unit step response for open loop simulink block diagrams

Specify Transfer Functions

- Transfer Function
  - Ratio of two polynomials
  - Polynomials: stored in terms of its coefficients in Matlab
  - $g(1) = s^2 + 3$
  - Roots of polynomial
    - roots(g1): roots of the polynomial g1
    - Using poly(): polynomial by the roots
  - $g(2) = 4s^3 + 6s^2 + 8s + 9$
  - Transfer function = g(1)/g(2)
  - For transfer function, syntax is tf
  - Addition, subtraction, multiplication and division can be carried out on transfer functions like scalars

CH3101 – Tutorial 5

Specify Transfer Functions

Command Window

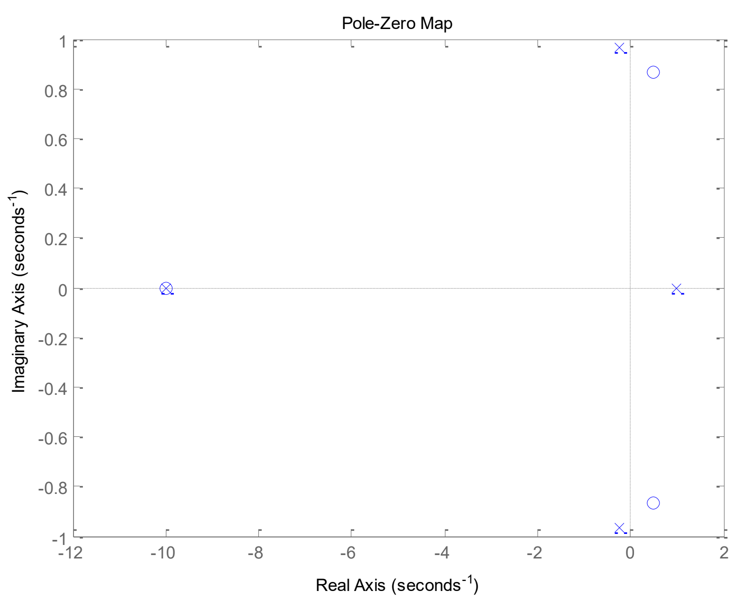
```
>> g1= [1 0 3]

g1 =

     1     0     3

>> g2=[4 6 8 9]

g2 =

     4     6     8     9

>> g = tf(g1, g2)

g =

          s^2 + 3
  -----------------------
  4 s^3 + 6 s^2 + 8 s + 9

Continuous-time transfer function.

>> g = tf([1 0 3], [4 6 8 9])

g =

          s^2 + 3
  -----------------------
  4 s^3 + 6 s^2 + 8 s + 9

Continuous-time transfer function.
```

What If TF Has a Time-Delay?

- $G(s) = \frac{s^2+3}{4s^3+6s^2+8s+9} e^{-5s}$
  - g = tf([1 0 3],[4 6 8 9],'inputdelay',5)
- Pole(g)
  - roots of denominator polynomial
- Zero(g)
  - roots of numerator polynomial
- Dcgain(g)
  - Steady State Gain

Syntax

- pzmap(g1)
  - Plot containing location of poles and zeros
- $g1(s) = \dfrac{s^3+9s^2-9s+10}{s^4+9.5s^3-4.5s^2+4s-10}$



Command Window

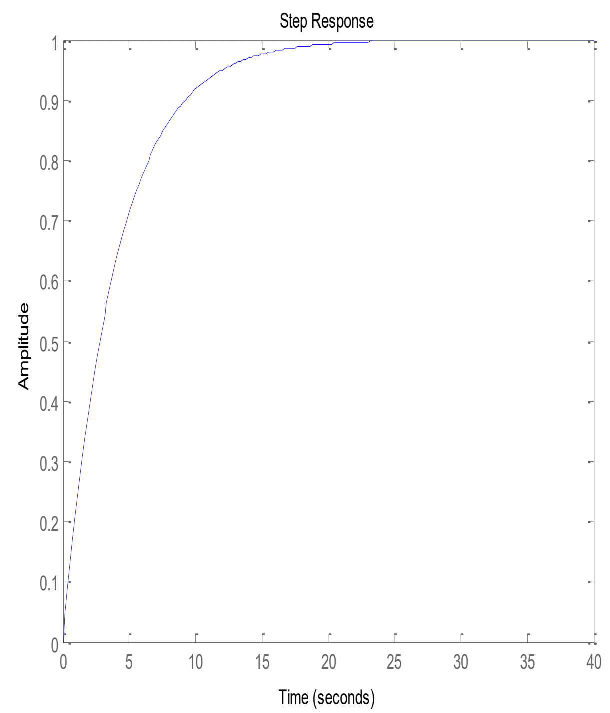
```
>> g1=tf([1 9 -9 10],[1 9.5 -4.5 4 -10])

g1 =

        s^3 + 9 s^2 - 9 s + 10
  ----------------------------------
  s^4 + 9.5 s^3 - 4.5 s^2 + 4 s - 10

Continuous-time transfer function.

>> pzmap(g1)
>> pole(g1)

ans =

 -10.0000
   1.0000
  -0.2500 + 0.9682i
  -0.2500 - 0.9682i

>> zero(g1)

ans =

 -10.0000
   0.5000 + 0.8660i
   0.5000 - 0.8660i

>> dcgain(g1)
```

Step and Impulse Response

- Step Response
  - step(g) where g is the transfer function
  - Input function is a unit step
  - $g = \frac{1}{4s+1}$
  - step(g, 30)
    - Step response starting at time 0 and ending at time = 30 sec
  - step(g, 0:1:30)
    - Step response at time vector [0,1,2,…..,30]
  - [y,t]=step(g,30)
  - [y,t]=step(10*g, 30)
    - The process response with a step change of 10 units in the input
- Impulse Response
  - Impulse(g)

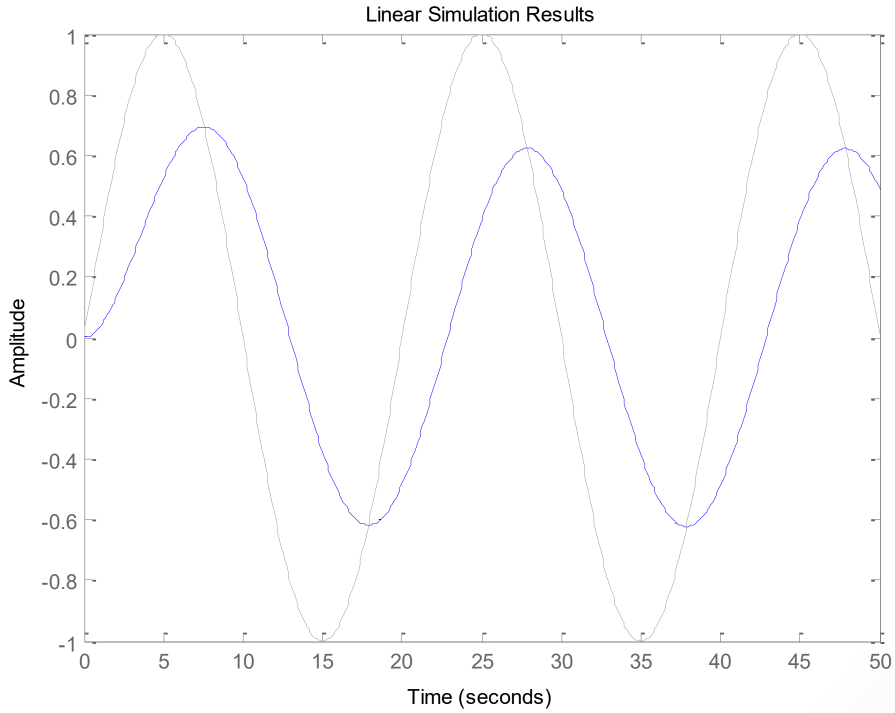
Step and Impulse Response

```
>> g = tf([1], [4,1])

g =

      1
   -------
   4 s + 1

Continuous-time transfer function.

>> step(g)
```



Response for Arbitrary Input Change

- lsim(model, input, time)
  - u = sin(0.1*pi*t)
  - t = [0:1:50]
  - lsim(g,u,t)
- Alternatively,
  - y = lsim(g, u, t)
  - plot(t, y, t, u)



References

For more information on MATLAB, please refer to the following sources:

- http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf
- Help control
- http://www.mathworks.com/help/pdf_doc/control/usingcontrol.pdf
- http://www.mathworks.com/help/simulink/index.html

Tutorial 5

The End