CHAPTER 5 : INTRODUCTION TO COMPUTER SIMULATION

MATLAB (MAThematical LABoratory) Version 7

A) INPUTS

- **Polynomials :** $P_1 = s^3 + 7s^2 - 3s + 23$
  - >> **P1=[1 7 -3 23]**
- **Polynomials in factor form :** $P_2 = (s+2)(s+5)(s+6)$
  - >> **P2=poly([-2 -5 -6])**

B) DISPLAYS & ALGEBRAIC SOLUTIONS

- **To display variables :**
  - >> **P1**
  - >> **P2**
- **Finding roots of polynomials : using the *roots( )* command**
  - >> **rootsP1=roots(P1)**
- **Multiplying polynomials : using the *conv(a,b)* command**
  - $P_3 = (s^3 + 7s^2 + 10s + 9)(s^4 - 3s^3 + 6s^2 + 2s + 1)$
    - >> **a=[1 7 10 9]**
>> **b=[1 -3 6 2 1]**
>> **P3=conv(a,b)**

C) <u>CREATING TRANSFER FUNCTIONS</u>

- **Basic : 2 forms,**

  - **Polynomial form – numerator poly. is divided by denominator poly.**

  - $G_1(s) = \dfrac{150(s^2 + 2s + 7)}{s(s^2 + 5s + 4)} = \dfrac{150(s^2 + 2s + 7)}{s^3 + 5s^2 + 4s}$

    - \>> **num1=150*[1 2 7]**

      \>> **den1=[1 5 4 0]**

      \>> **G1=tf(num1,den1)**

  - **Factored form – numerator in factor form is divided by denominator in factor form.**

  - $G_2(s) = \dfrac{20(s+2)(s+4)}{(s+7)(s+8)(s+9)}$

    - \>> **K=20**

      \>> **num2=[-2 -4]**

      \>> **den2=[-7 -8 -9]**

      \>> **G2=zpk(num2,den2,K)**

- **Rational expression in ‘*s*’ method**

  - **This method allows you to type in the transfer function as you normally would write it.**

  - **The statement *s=tf(‘s’)* must precede the transfer function you wish to type in (in polynomial form), which is equivalent to G=tf(num,den)**

  - \>> **s=tf(‘s’)**

    \>> **G1=150*(s^2+2*s+7)/[s*(s^2+5*s+4)]**

    \>> **G2=20*(s+2)*(s+4)/[(s+7)*(s+8)*(s+9)]**

- **The statement *s=zpk('s')* must precede the transfer function you wish to type in (in polynomial form), which is equivalent to G=zpk(num,den,K)**

  - **>> s=zpk('s')**

    >> G1=150*(s^2+2*s+7)/[s*(s^2+5*s+4)]

    >> G2=20*(s+2)*(s+4)/[(s+7)*(s+8)*(s+9)]

- **Transfer function can also be converted between polynomial form containing the coefficients and factored form containing the roots.**

  - **tf2zp(numtf,dentf) : converts the coefficients to roots**

    - **>> numg1=150*[1 2 7]**

      >> deng1=[1 5 4 0]

      >> [numg1zp,deng1zp]=tf2zp(numg1,deng1)

  - **zp2tf(numzp,denzp,K) : converts the roots to coefficients**

    - **>> K=20**

      >> numg2=[-2 –4]

      >> deng2=[-7 –8 –9]

      >> [numg2tf,deng2tf]=zp2tf(numg2,deng2,K)

- **Reduction of simple subsystems**

  - **Combining two transfer function connected in series**

    - **>> G3=G1*G2**

  - **Combining two transfer function connected in parallel**

    - **>> G4=G1+G2**

  - **Obtaining a closed loop negative feedback transfer function**

    - **>> G5=G1/(1+G1*G2)** ***if G2 is the feedback tf***

D) TIME DOMAIN RESPONSES

- The response of a system can be viewed by using the *ltiview( )* command; example – all the responses from the above transfer function can be obtained by

    - >> ltiview(G1)

    - >> ltiview(G2)

    - >> ltiview(G3)

    - >> ltiview(G4)

- From the *ltiview( )*, we can obtain (by clicking the right button on the mouse with the pointer on the graph)

    - the output response from a step function input,

    - the plotting of poles and zeros of a system,

    - the characteristics of a system response

- We can also use another command (used especially in designing of a controller) to view the output response of a system : *sisotool( )*.

E) MATLAB'S SIMULINK

- Another way of simulating a system with a given transfer function.

- Using the concept of block diagram visualization.

- Can be accesses by typing '*simulink*' in the Matlab workspace.

- Select blocks from the *Simulink Library Browser* – the transfer function block can be found in the '*Continuous*' library; the input signal blocks can be found in the '*Sources*' library; the output display blocks can be found in the '*Sinks*' library.

- **All the necessary blocks can be selected by click-and-drag into the new file workspace.**

- **Lines for interconnection between blocks can drawn by clicking-hold-and-drag to the required destination.**

- **The parameters for every block can be chosen or changed by double-clicking the required block.**

- **Simulation can be started by selecting from the menu bar '*Simulation*' and '*Start*'.**

- **After the simulation has finished running, the output can be visualized by 'double-clicking' the *Sinks* block, respectively.**

- ***<u>Further and details notes on using the MATLAB can be found in Appendix B, C and D of the N. Nise textbook (pgs. 852-939).</u>***