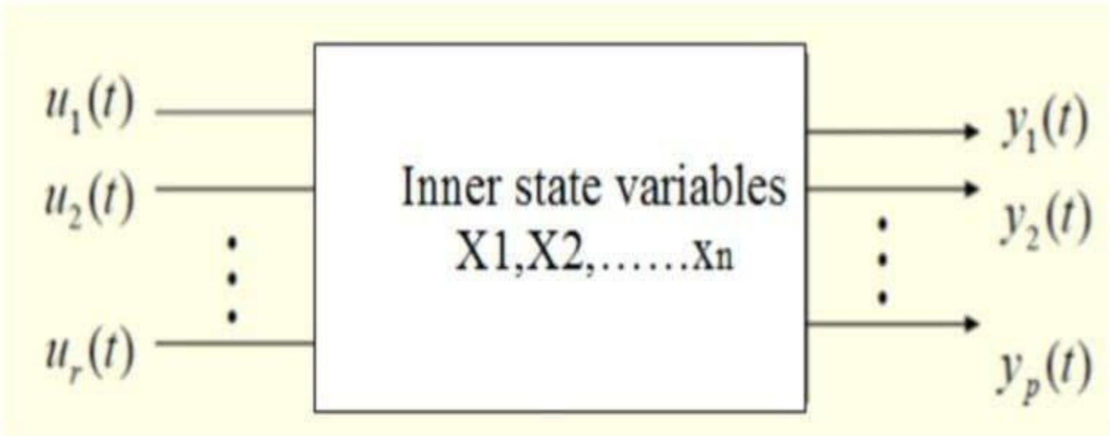
EXPERMINT NO.2

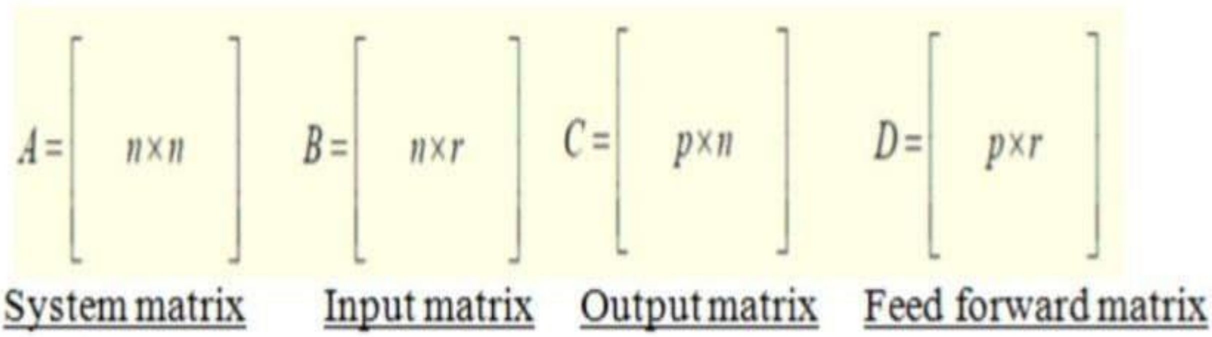
STATE SPACE &BLOCK DIAGRAM

1.1 State space

The classical control theory and methods are based on a simple input-output relationship of the plant, usually expressed as a transfer function. These methods do not use any knowledge of the interior structure of the plant, and limit us to single-input single-output (SISO) systems, and as we have seen allows only limited control of the closed-loop behavior when feedback control is used.



$$\dot{x}(t) = Ax(t) + Bu(t) \qquad y(t) = Cx(t) + Du(t)$$

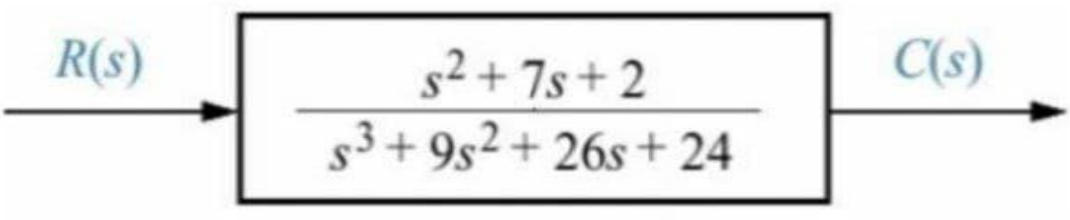


Commands

The commands used in this lab are:

Command	Specification
tf2zp	Convert transfer function filter parameters to zero-pole-gain form
zp2tf	Convert zero-pole-gain filter parameters to transfer function form
ss2tf	Convert state-space filter parameters to transfer function form
tf2ss	Convert transfer function filter parameters to state-space form
zp2ss	Convert zero-pole-gain filter parameters to state-space form
ss2zp	Convert state-space filter parameters to zero-pole-gain form

Example1: A control system is characterized by the transfer function shown in figure below. determine the state-space representation



ANS:

num=[1 7 2];

den=[1 9 26 24];

[a b c d]=tf2ss(num,den)

Example2: Find the transfer function for the following state model.

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}u$$

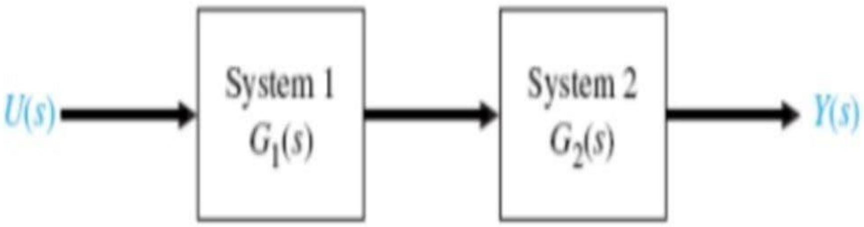
$$y = [1 \quad 0 \quad 0]\mathbf{x}$$

ANS:

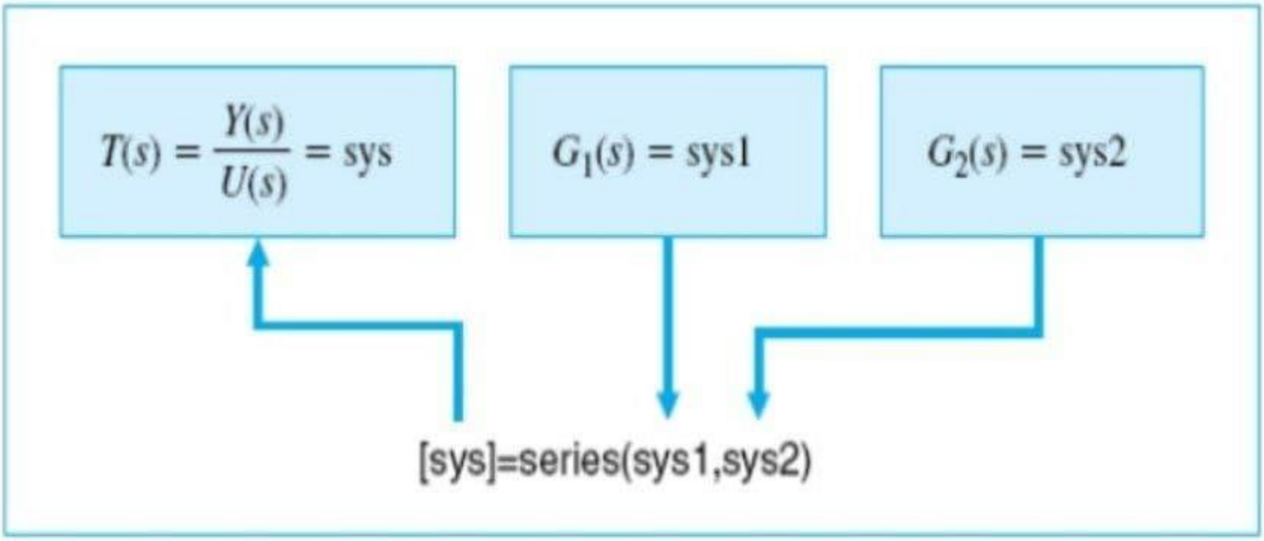
```
a=[0 1 0 ; 0 0 1 ; -1 -2 -3];

b=[10 ; 0 ; 0];

c=[1 0 0];

d=0;

[num,den]=ss2tf(a,b,c,d);

sys=tf(num,den)
```

1.2 Block Digram Reduction

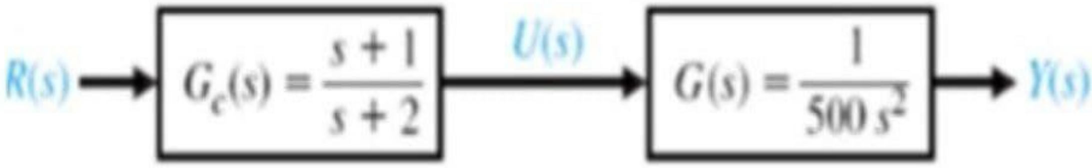
Series Configuration: If the blocks are connected as shown below then the blocks are said to be in series.It would like multiplying two transfer function.The MATLAB command for the such configuration is "series"



The series command is implement as shown below:



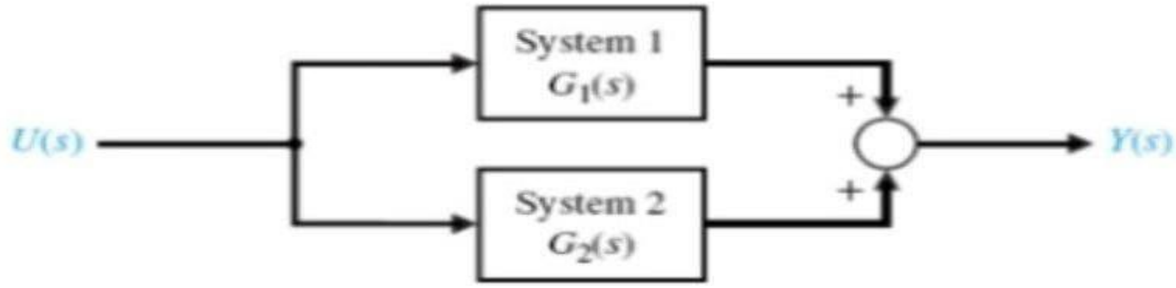
Example 3: Given the transfer function of individual blocks generate the system transfer function of the block combinations.



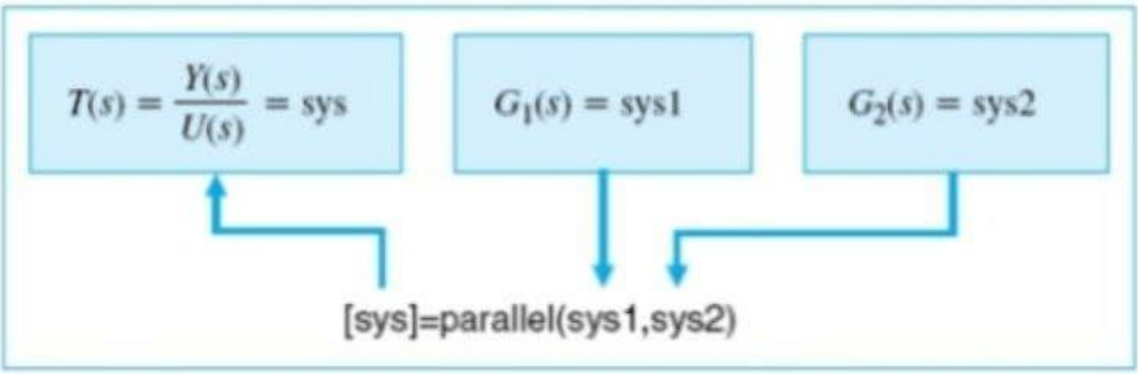
ANS:

```
numgc=[1 1];dengc=[1 2];sysgc=tf(numgc,dengc);

numg=[1];deng=[500 0 0];sysg=tf(numg,deng);

sys=series(sysgc,sysg)
```

Parallel configuration: If the blocks are connected as shown below then the blocks are said to be in parallel .It would like adding two transfer functions.



The MATLAB command for implementing a parallel configuration is "parallel" as shown blow:

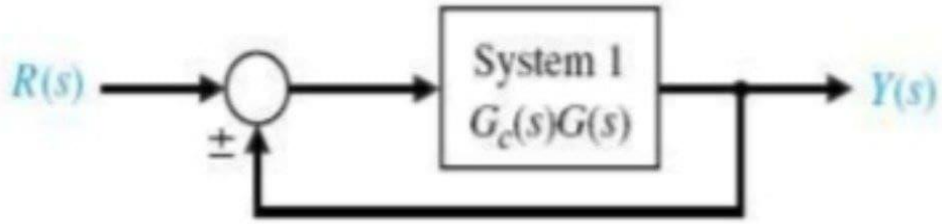


Example 4:for previous system defined,modify the MATLAB command to obtain the overall transfer function when the two blocks are in parallel

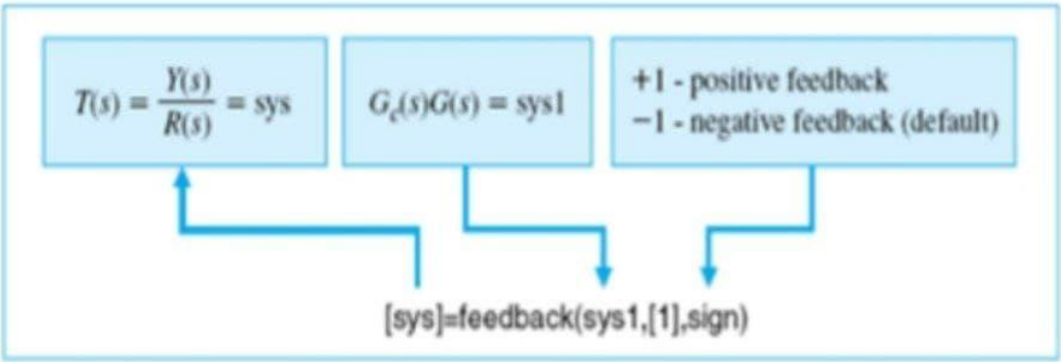
ANS:

```
numgc=[1 1];dengc=[1 2];sysgc=tf(numgc,dengc);

numg=[1];deng=[500 0 0];sysg=tf(numg,deng);

sys=parallel(sysgc,sysg)
```

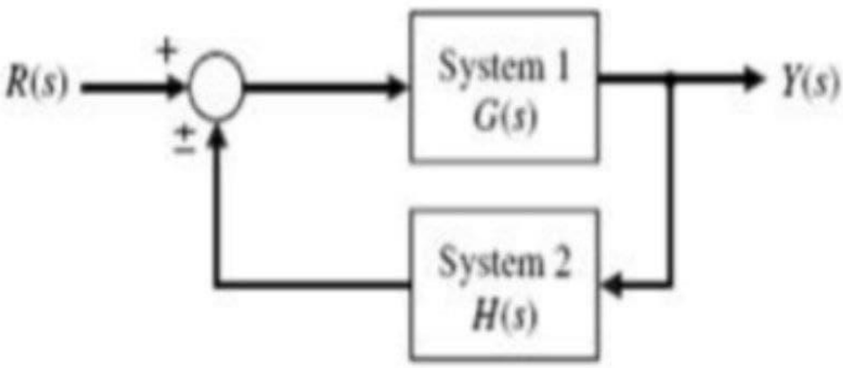
Feedback configuration: If the blocks are connected as shown below then the blocks are said to be in feedback.Notice that in the feedback there is no transfer function H(s) defined.When not specified,H(s) is unity.Such a system is said to be a unity feedback system.



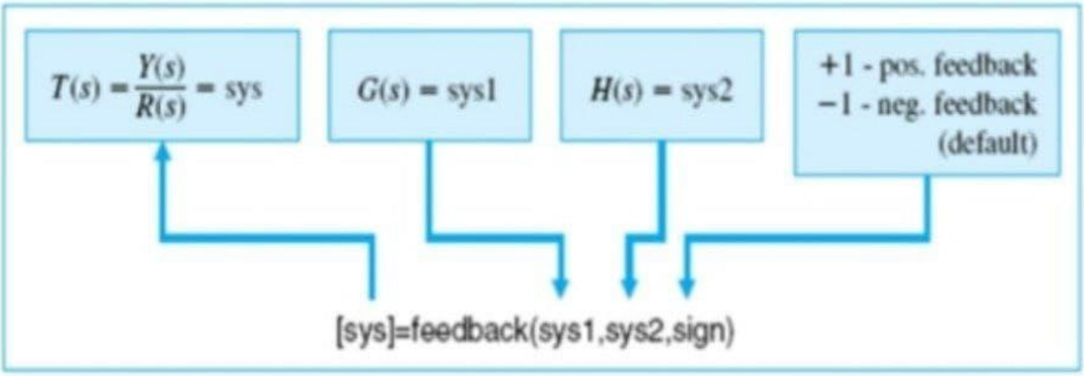
The MATLAB command for implementing a feedback configuration is "feedback" as shown blow:



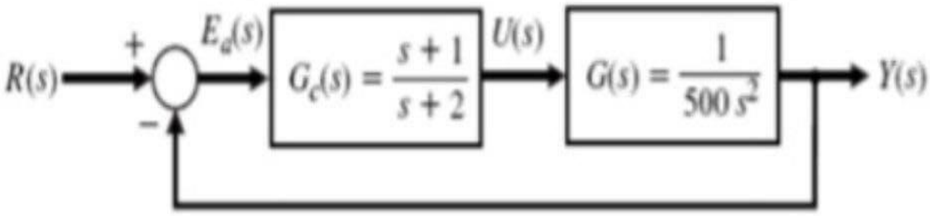
When **H(s)** is non-unity or specified,such a system is said to be a non-unity feedback system as shown below:



a non-unity feedback system is implemented in MATLAB using the same "feedback" command as shown:



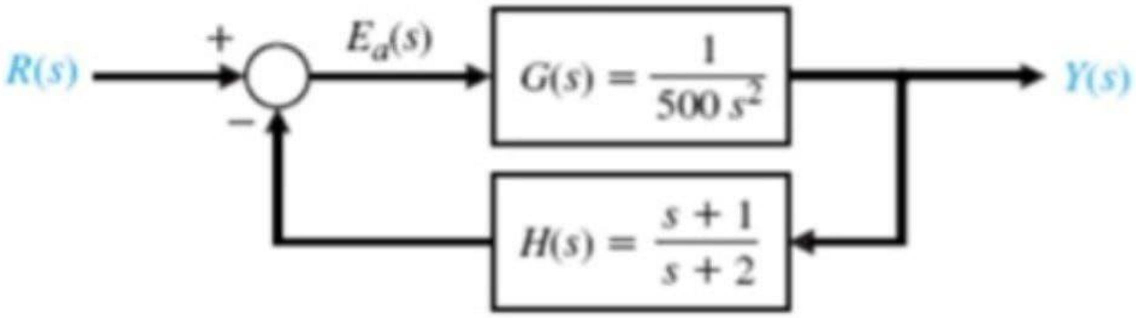
Example 5: Given a unity feedback system as shown in figure, obtain the overall transfer function using MATLAB



ANS:

```
numgc=[1 1];dengc=[1 2];sysgc=tf(numgc,dengc);

numg=[1];deng=[500 0 0];sysg=tf(numg,deng);

sysf=series(sysgc,sysg);

sys=feedback(sysf,1,-1)
```

Example 6: Given a non- unity feedback system as shown in figure,obtain the overall transfer function using MATLAB

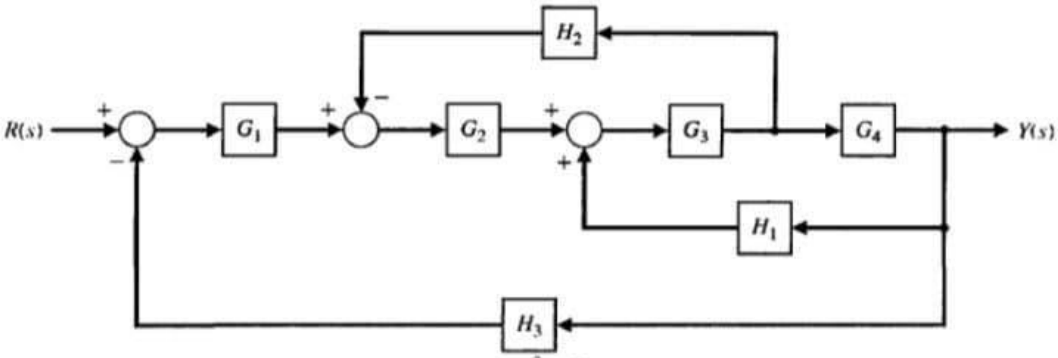


ANS:

```
numf=[1];denf=[500 0 0];sysf=tf(numf,denf);

numh=[1 1];denh=[1 2];sysh=tf(numh,denh);

sys=feedback(sysf,sysh,-1)
```

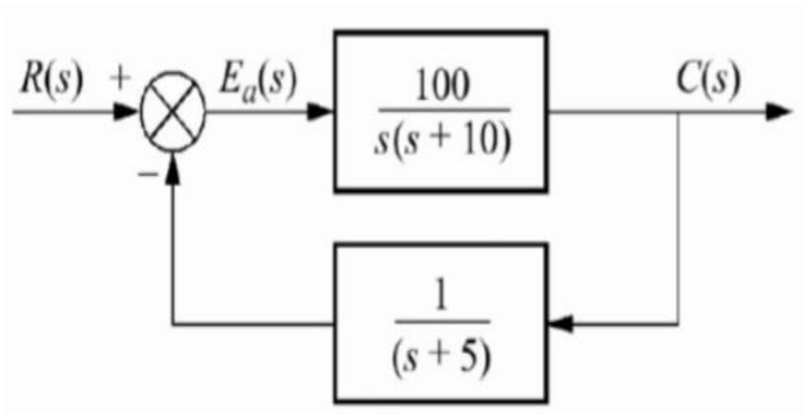
HOMEWORKS

(1) For the following system obtain the overall transfer function using MATLAB



Given $G_1 = \frac{1}{(s+10)}$; $G_2 = \frac{1}{(s+1)}$; $G_3 = \frac{s^2+1}{(s^2+4s+4)}$; $G_4 = \frac{s+1}{(s+6)}$; $H_1 = \frac{s+1}{(s+2)}$; $H_2 = 2$; $H_3=1$

(2) Consider the control systems in figures below, determine the state Space representation



(3) Consider the systems equations below, Determine transfer function

$$\dot{X} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [u]$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$