#.Find the transfer function from the following state equations

1.

$$\dot{\mathbf{x}} = \begin{bmatrix} -2 & -1 \\ -3 & -5 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 1 \\ 2 \end{bmatrix}u(t)$$

$$y = \begin{bmatrix} 3 & 2 \end{bmatrix}\mathbf{x}$$

Matlab Code:

```
>> A=[-2 -1;-3 -5];
>>  B=[1 2]';
>> C=[3 2];
>> D=0;
>> T=ss(A,B,C,D);
>> T=tf(T)
```

Output:

```
Transfer function:
  7 s + 11
-------------
s^2 + 7 s + 7
```

2.

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 2 & 3 \\ 0 & 6 & 5 \\ 1 & 4 & 2 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}u(t)$$

$$y = \begin{bmatrix} 1 & 2 & 0 \end{bmatrix}\mathbf{x}$$

Matlab Code:

```
>> A=[0 2 3;0 6 5;1 4 2];
>> B=[0 1 1]';
>> C=[1 2 0];
>> D=0;
>> T=ss(A,B,C,D);
>> T=tf(T)
```

1.

$$G(s) = \frac{400}{s^2 + 12s + 400}$$

Matlab Code:

```
>> y=tf([400],[1 128 400]);
>> pzmap(y);
>> sgrid
>> [wn,z]=damp(y)
```

Output:

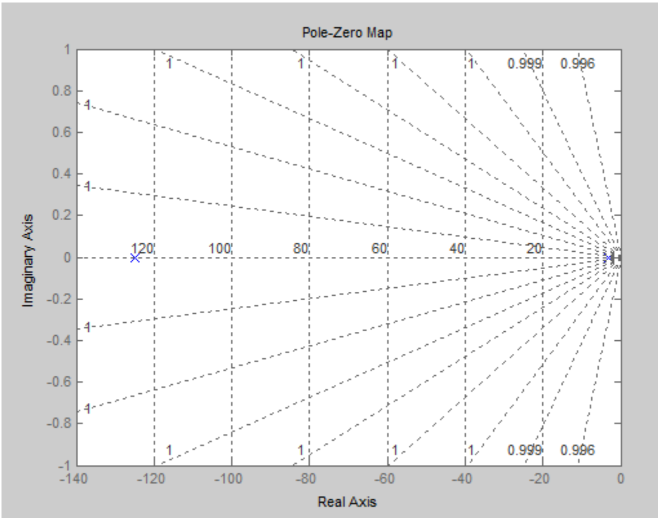
```
wn =

    3.2053
  124.7947


z =

     1
     1
```

Figure:



2.

$$G(s) = \frac{900}{s^2 + 90s + 900}$$

Matlab Code:

```
>> y=tf([900],[1 90 900]);
>>  pzmap(y)
>> sgrid
>> [wn,z]=damp(y)
```

Output:

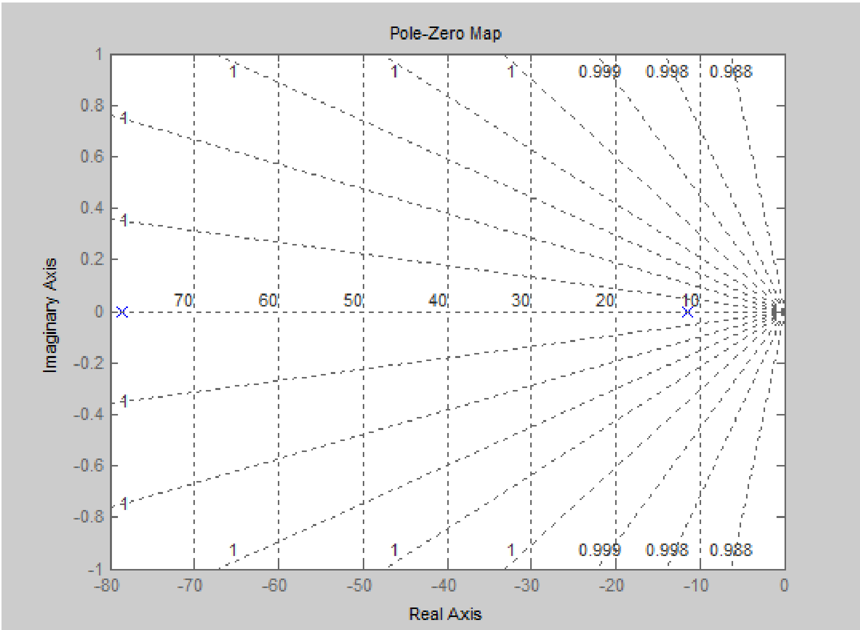
```
wn =

   11.4590
   78.5410


z =

     1
     1
```

Figure:



3.

$$G(s) = \frac{225}{s^2 + 30s + 225}$$

Matlab Code:

```
>> y=tf([225],[1 30 225]);
>> pzmap(y)
>> sgrid
>> [wn,z]=damp(y)
```

Output:

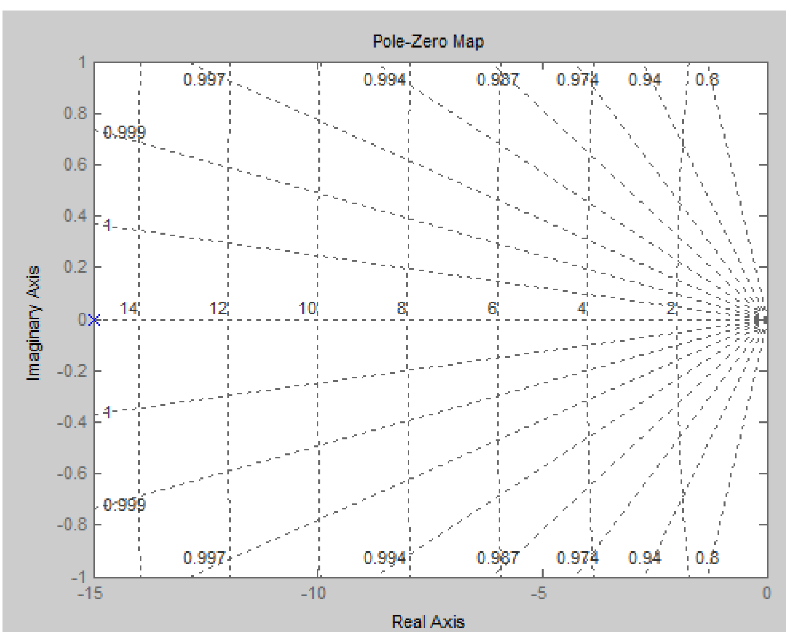
```
wn =

   15.0000
   15.0000


z =

     1
     1
```

Figure:



4.

$$G(s) = \frac{625}{s^2 + 625}$$

Matlab Code:

```
>> y=tf([625],[1 0 625]);
>> pzmap(y)
>> sgrid
>> [wn,z]=damp(y)
```

Output:

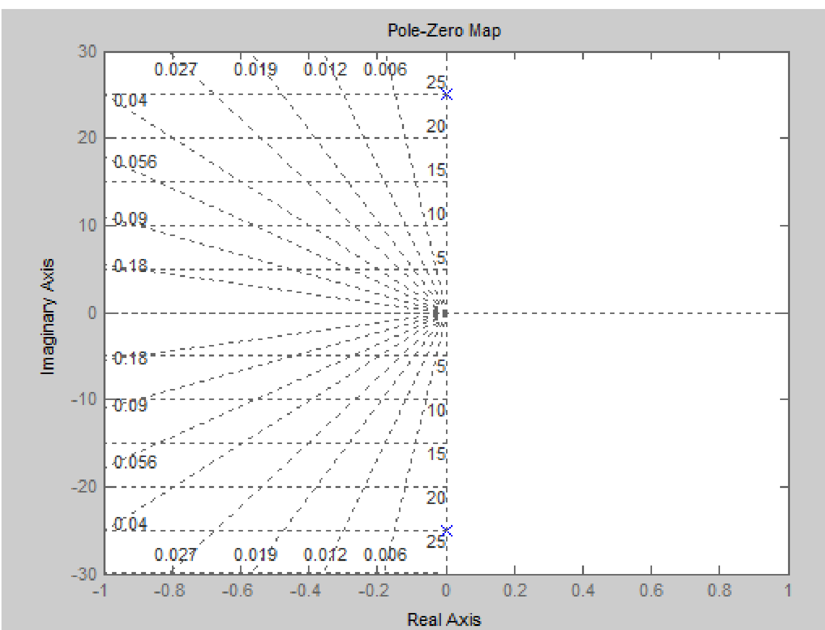
```
wn =

   25.0000
   25.0000


z =

     0
     0
```

Figure:



#.Print a system when natural frequency (ωn) and damping ratio (ξ) are given

1.

For $\omega_n = 10$ rad/sec and $\xi = 0.3$

Matlab Code:

```
>> wn=10;
>> damping_ratio=0.3;
>> [num,den]=ord2(wn,damping_ratio)

num =

     1



den =

     1     6   100

>> num=wn^2;
>> printsys(num,den,'s')
```

Output:

```
num/den =

           100
   ----------------
   s^2 + 6 s + 100
```

2.

For $\omega_n = 20$ rad/sec and $\xi = 0.0$

Matlab Code:

```
>> wn=20;
>> dam=0.0;
>> [num,den]=ord2(wn,dam)

num =

     1


den =

     1     0   400

>> num=wn^2

num =

   400

>> printsys(num,den,'s')
```

Output:

```
num/den =

      400
   ---------
   s^2 + 400
```

3.

For $\omega_n = 25$ rad/sec and $\xi = 0.8$

Matlab Code:

```
>> wn=25;
>> dam=0.8;
>> [num,den]=ord2(wn,dam)

num =

     1



den =

     1    40   625

>> num=wn^2;
>> printsys(num,den,'s')
```

Output:

```
num/den =

           625
    ----------------
    s^2 + 40 s + 625
```

4.

For $\omega_n = 30$ rad/sec and $\xi = 1.0$

Matlab Code:

```
>> wn=30;
>> dam=1;
>> [num,den]=ord2(wn,dam)

num =

     1



den =

     1    60   900

>> num=wn^2;
>> printsys(num,den,'s')
```

Output:

```
num/den =

          900
   ----------------
   s^2 + 60 s + 900
```

#.Using MATLAB, obtain the unit-step response, unit-ramp response, and unit-impulse response of the following system

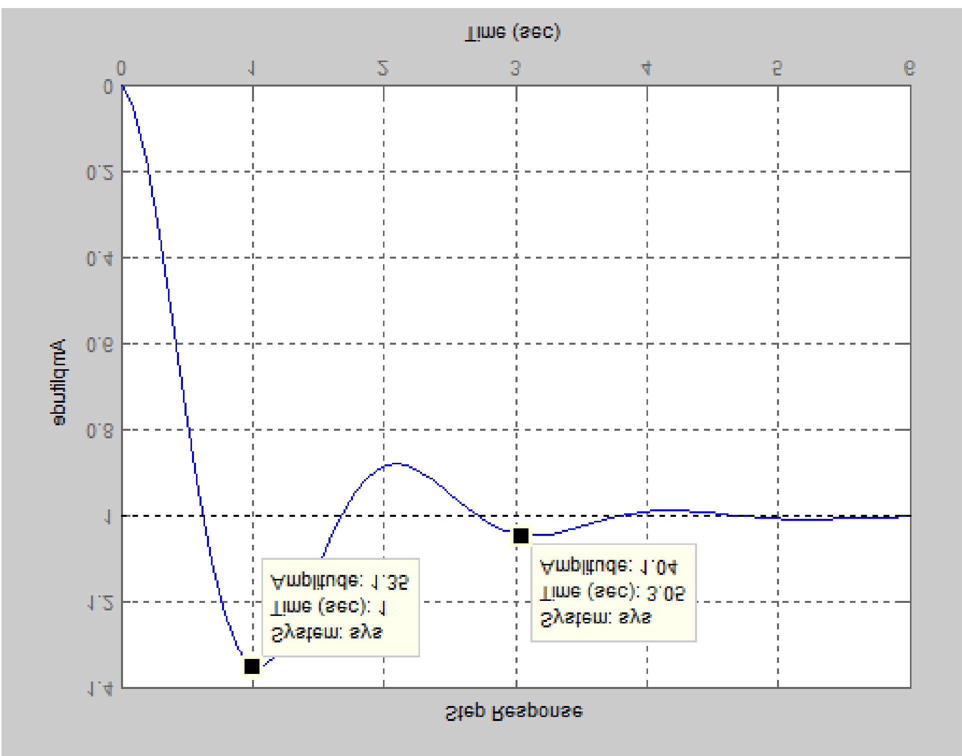
$$\frac{C(s)}{R(s)} = \frac{10}{s^2 + 2s + 10}$$

Unit Step Response

Matlab Code:

```
>> num=10;
>> den=[1 2 10];
>> step(num,den)
>> grid on
```

Output:

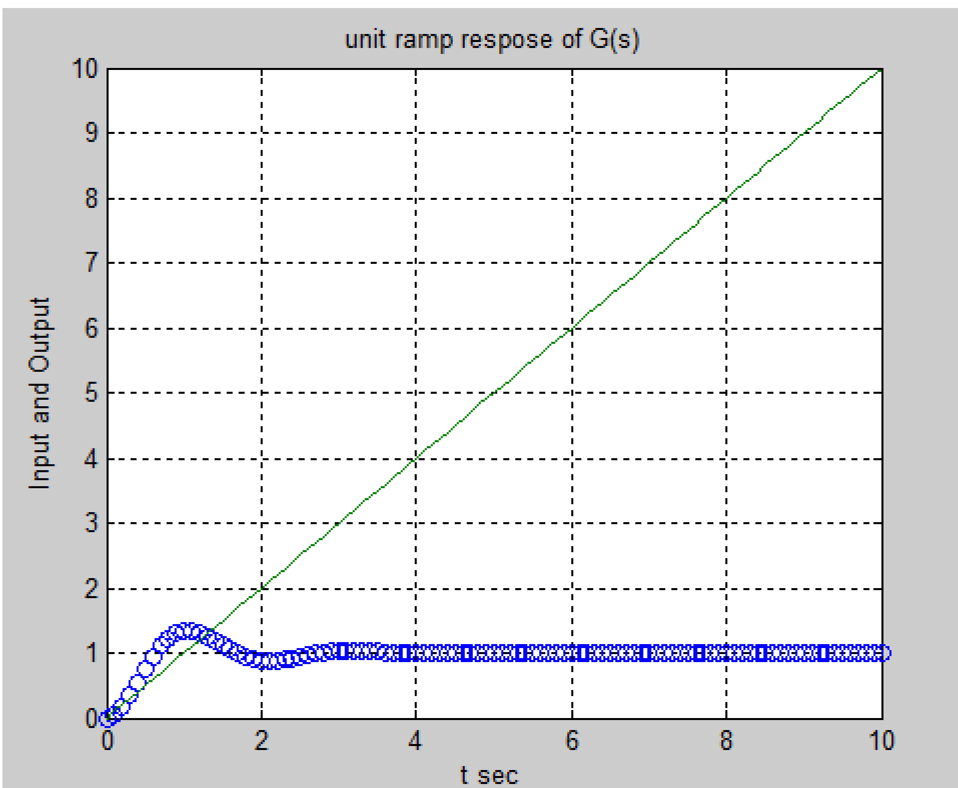


Unit Ramp Respoonse

Matlab Code:

```
>> num=10;
>> den=[1 2 10];
>> t=0:0.1:10;
>> c=step(num,den,t);
>> plot(t,c,'o',t,t,'-')
>> grid
>> title('unit ramp respose of G(s)')
>> xlabel('t sec')
>> ylabel('Input and Output')
>>
```

Output:

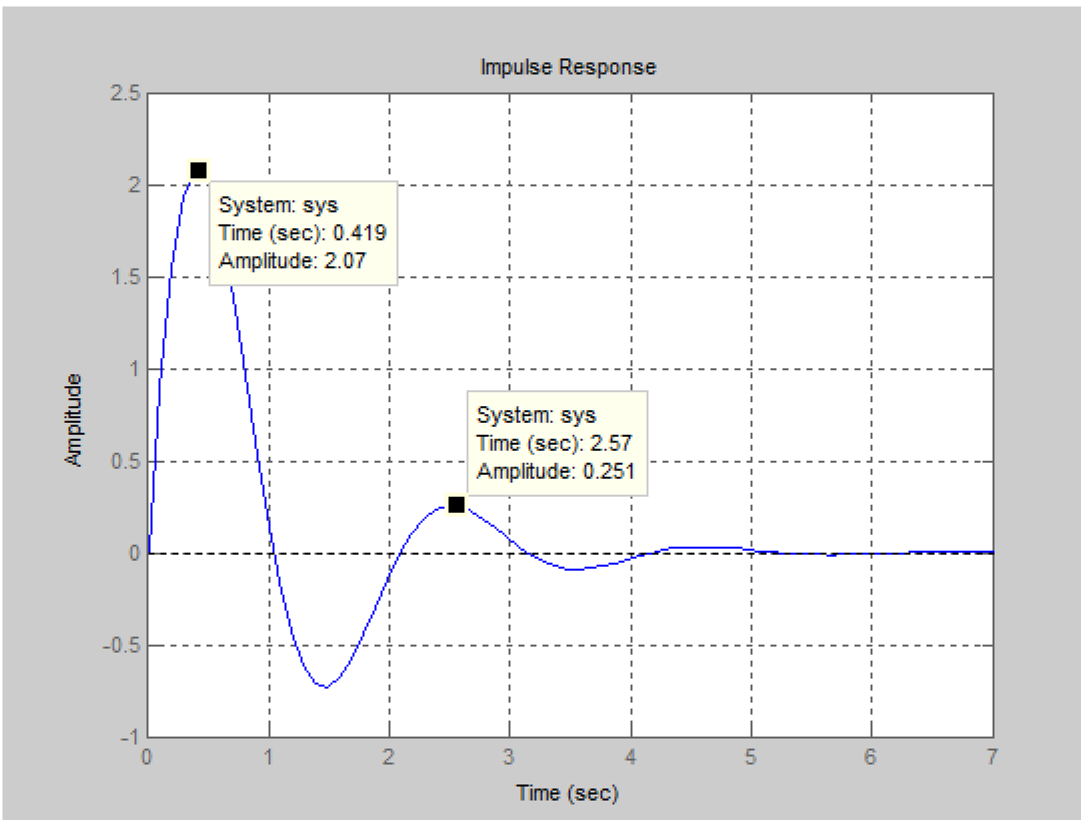


Unit Impulse Response

Matlab Code:

```
>> num=10;
>> den=[1 2 10];
>> impulse(num,den)
>> grid on
```

Output:



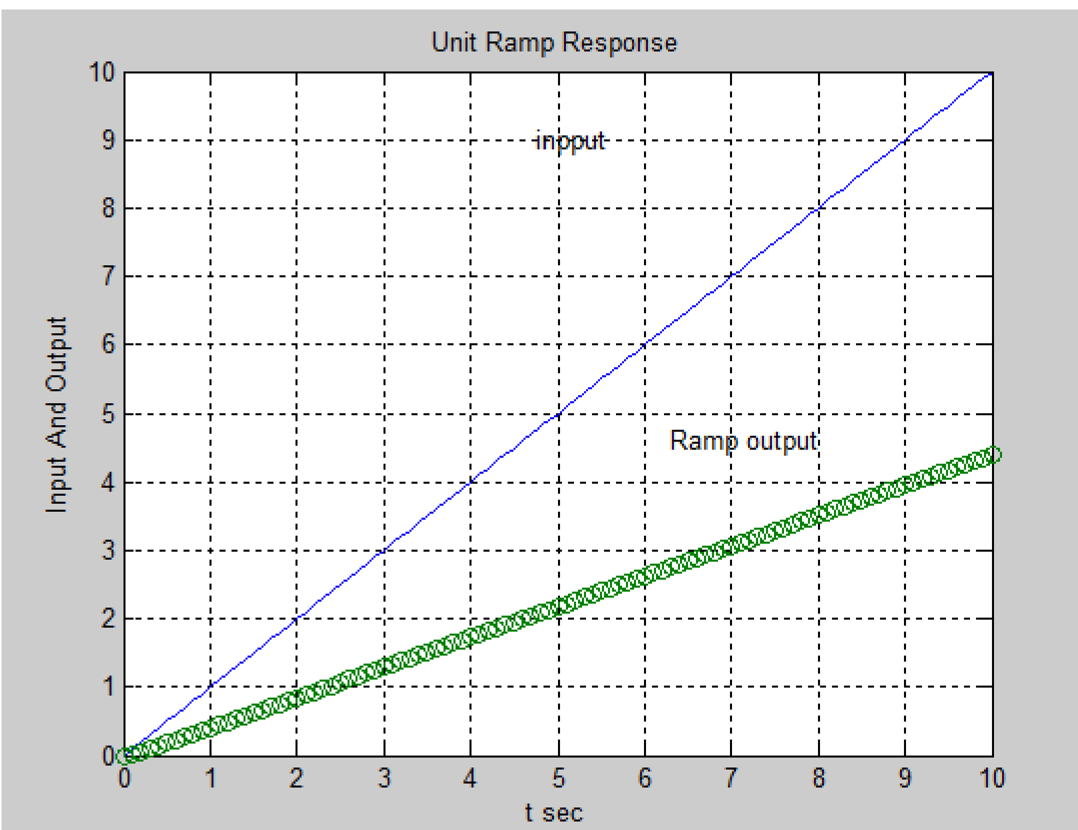
#.Obtain the unit-ramp response of three transfer functions using "lsim" command

1. $\frac{400}{s^2+90s+900}$

Matlab Code:

```
>> num=400;
>> den=[1 90 900];
>> t=0:0.1:10;
>> r=t;
>> y=lsim(num,den,r,t);
>> plot(t,r,'-',t,y,'o')
>> grid
>> title('Unit Ramp Response')
>> xlabel('t sec')
>> ylabel('Input And Output')
>> text(4.75,9.0,'inpput')
>> text(6.3,4.6,'Ramp output')
>> |
```

Output:

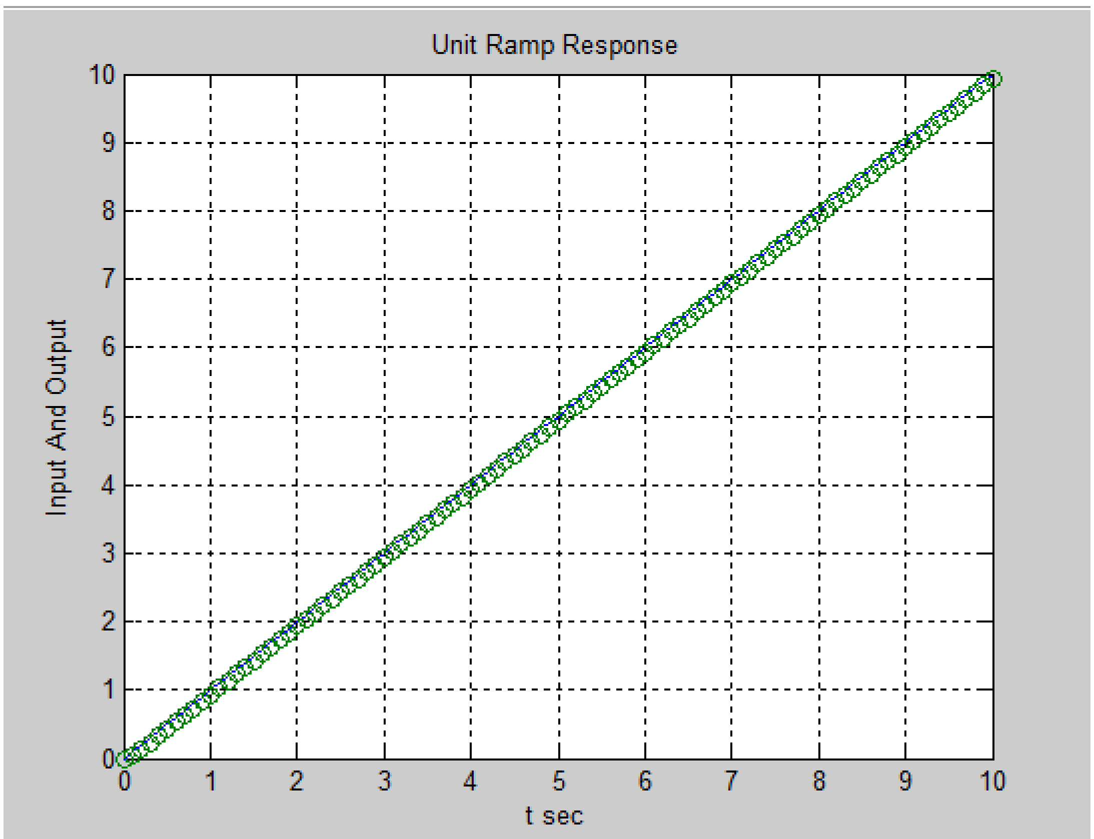


$2.\ \frac{400}{s^2+28s+400}$

Matlab Code:

```
>> num=400;
>> den=[1 28 400];
>> t=0:0.1:10;
>> r=t;
>> y=lsim(num,den,r,t);
>> plot(t,r,'-',t,y,'o')
>> grid
>> title('Unit Ramp Response')
>> xlabel('t sec')
>> ylabel('Input And Output')
>>
```

Output:

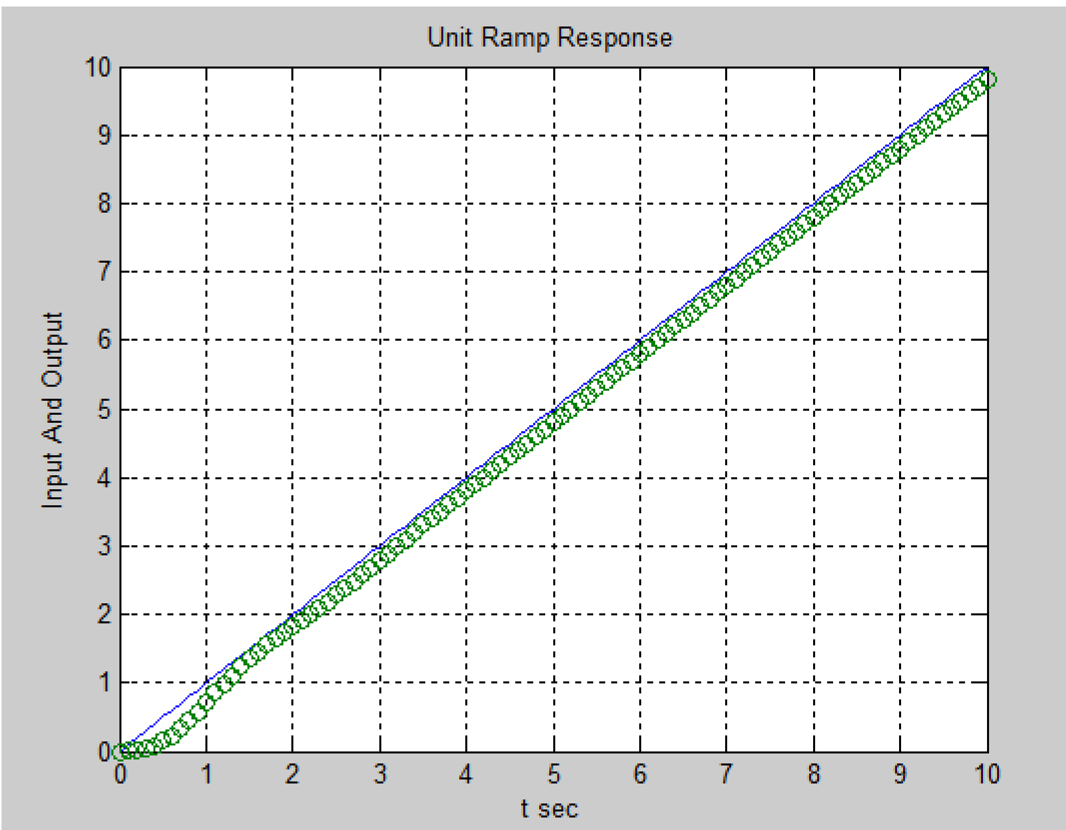


$$3. \frac{10}{s^2+2s+10}$$

Matlab Code:

```
>> num=10;
>> den=[1 2 10];
>> t=0:0.1:10;
>> r=t;
>> y=lsim(num,den,r,t);
>> plot(t,r,'-',t,y,'o')
>> grid
>> title('Unit Ramp Response')
>> xlabel('t sec')
>> ylabel('Input And Output')
>> |
```

Output:



#.Include step responses of overdamped, underdamped, critically damped and undamped system in a single figure using subplot command

a. $G(s) = \dfrac{400}{s^2 + 12s + 400}$

b. $G(s) = \dfrac{900}{s^2 + 90s + 900}$

c. $G(s) = \dfrac{225}{s^2 + 30s + 225}$

d. $G(s) = \dfrac{625}{s^2 + 625}$

Matlab Code:

```
>> %Underdamped
>> num=[400];
>> den=[1 12 400];
>> t1=tf(num,den);
>> subplot(221)
>> step(t1)
>> title('Underdamped')
>> %Overdamped
>> num2=[900];
>> den2=[1 90 900];
>> t2=tf(num2,den2)

Transfer function:
      900
----------------
s^2 + 90 s + 900

>> subplot(222)
>> step(t2)
>> title('Overdamped')
>>
```

```
>> %Underdamped
>> num=[400];
>> den=[1 12 400];
>> t1=tf(num,den);
>> subplot(221)
>> step(t1)
>> title('Underdamped')
>> %Overdamped
>> num2=[900];
>> den2=[1 90 900];
>> t2=tf(num2,den2)

Transfer function:
      900
----------------
s^2 + 90 s + 900

>> subplot(222)
>> step(t2)
>> title('Overdamped')
>>
```

Output: