控制理论-编程作业-2、5章

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2.1

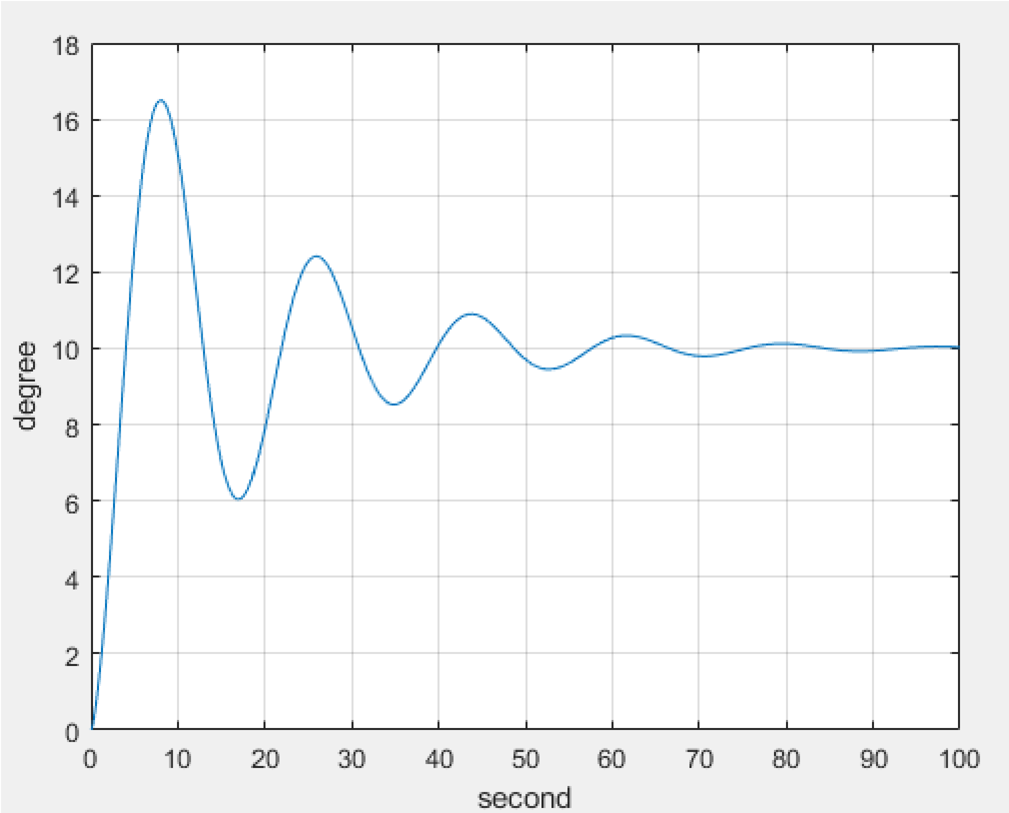
- 第一问

```
j=10.8e+8;k=10.8e+8;a=1;b=8;
num=k*[1 a];den=j*[1 b 0 0];
sys = tf(num,den);
sys = feedback(sys,[1],-1);
```

```
sys =

                1.08e09 s + 1.08e09
  --------------------------------------------------
  1.08e09 s^3 + 8.64e09 s^2 + 1.08e09 s + 1.08e09

Continuous-time transfer function.
```

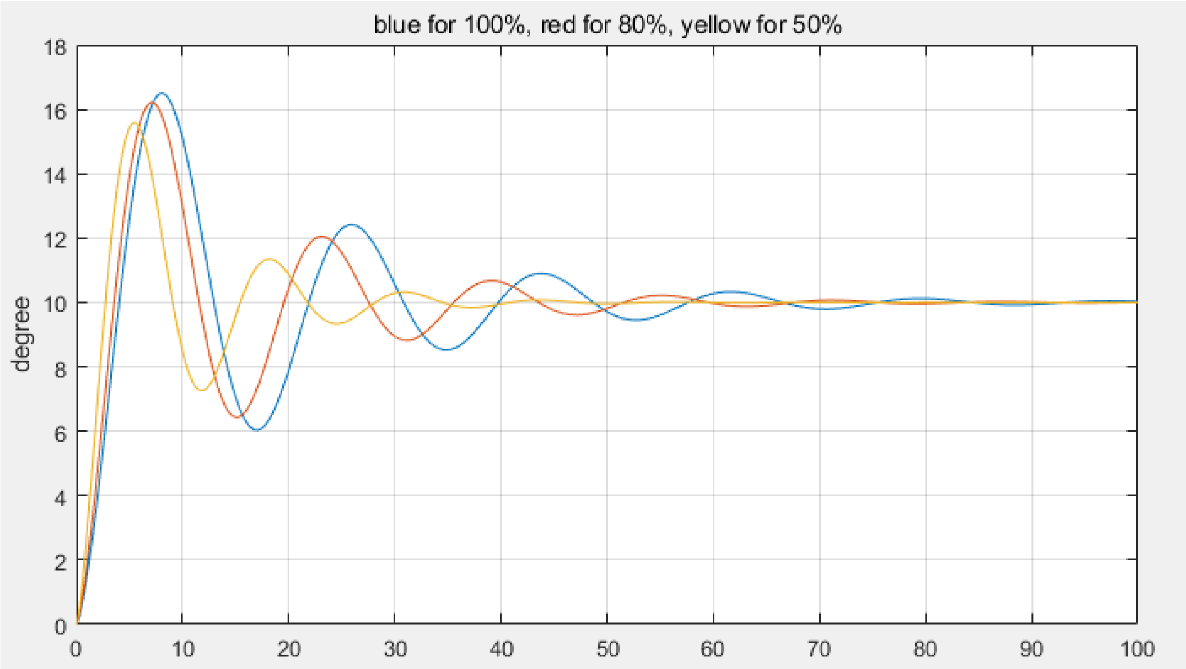
- 第二问

```
t = [0:0.1:100];

in = 10*pi/180;
out = sys*in;
y = step(out,t);
plot(t,y*180/pi),grid;
xlabel('second');
ylabel('degree');
```



- 第三问

```
j=10.8e+8*0.8;k=10.8e+8;a=1;b=8;
num=k*[1 a];den=j*[1 b 0 0];
sys = tf(num,den);
sys = feedback(sys,[1],-1);
in = 10*pi/180;
out = sys*in;
y1 = step(out,t);

j=10.8e+8*0.5;k=10.8e+8;a=1;b=8;
num=k*[1 a];den=j*[1 b 0 0];
sys = tf(num,den);
sys = feedback(sys,[1],-1);
in = 10*pi/180;
out = sys*in;
y2 = step(out,t);

plot(t,y*180/pi,t,y1*180/pi,t,y2*180/pi),grid;
xlabel('second');
ylabel('degree');
title('blue for 100%, red for 80%, yellow for 50%');
```



2.2

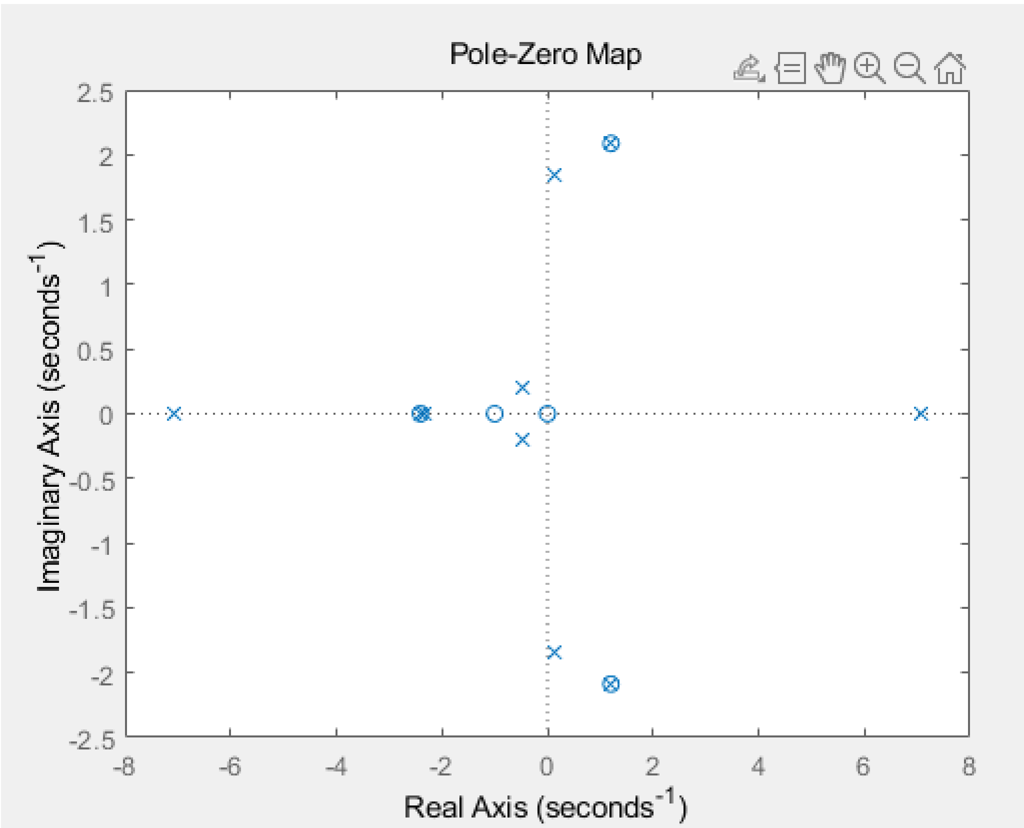
- 第一问

```
sys1=tf([1],[1 0 0]);
sys1=feedback(sys1,[50],1);

sys2=tf([1],[1,1]);
sys3=tf([1 0],[1 0 2]);
sys4=series(sys2,sys3);
sys5=tf([4 2],[1,2,1]);
sys6=feedback(sys4,sys5,-1);

sys7=series(sys6,sys1);
sys8=tf([1 0 2],[1 0 0 14]);
sys9=feedback(sys7,sys8,-1);

sys10=tf([4],[1]);
sys11=series(sys10,sys9);
sys11 = minreal(sys11)
```

```
sys11 =

              4 s^6 + 8 s^5 + 4 s^4 + 56 s^3 + 112 s^2 + 56 s
  ---------------------------------------------------------------------------
  s^10 + 3 s^9 - 45 s^8 - 125 s^7 - 200 s^6 - 1177 s^5 - 2344 s^4
                                     - 3485 s^3 - 7668 s^2 - 5598 s - 1400

Continuous-time transfer function.
```

- 第二问

```
pamap(sys11)
```



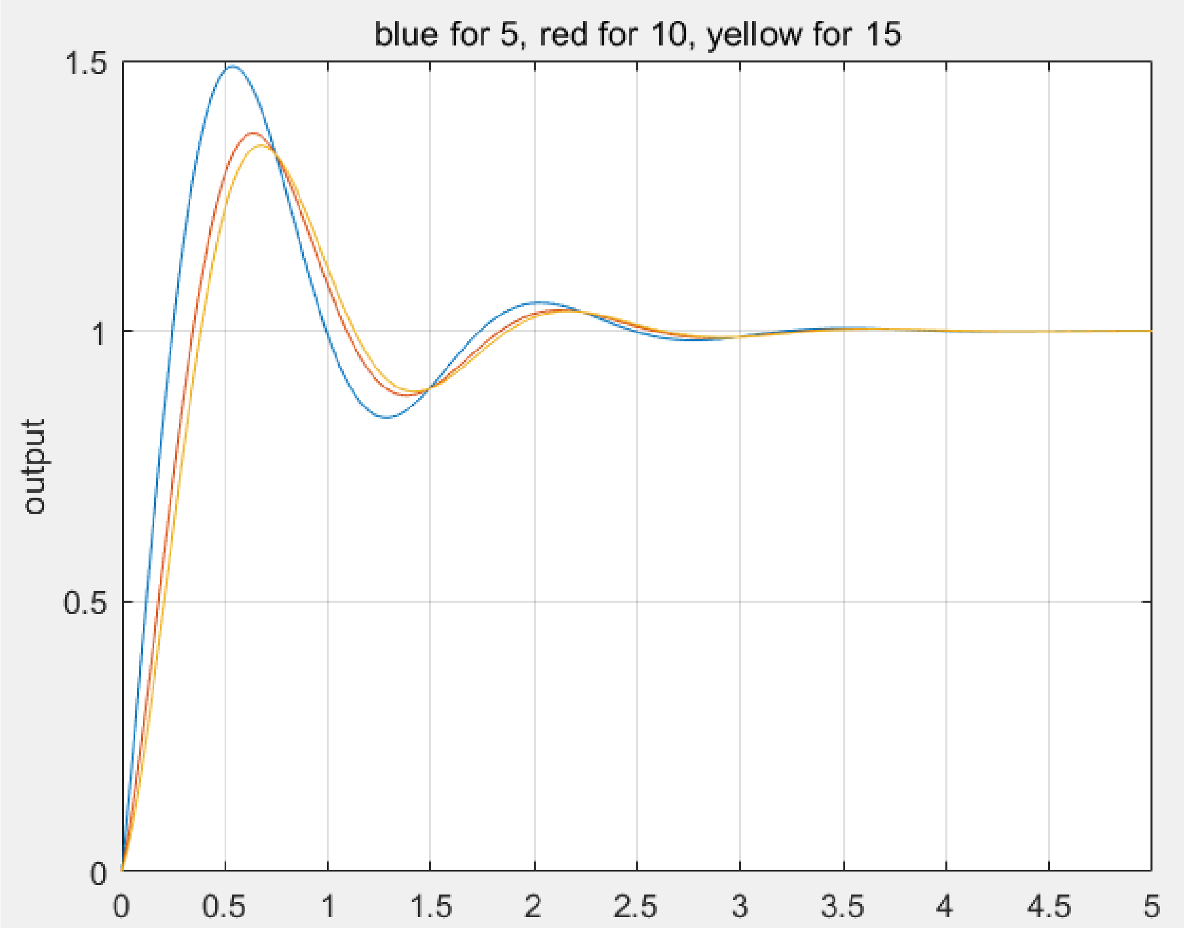
- 第三问

```
p=pole(sys11)
z=zero(sys11)
```

```
p =

   7.0709 + 0.0000i
  -7.0713 + 0.0000i
   1.2051 + 2.0863i
   1.2051 - 2.0863i
   0.1219 + 1.8374i
   0.1219 - 1.8374i
  -2.3933 + 0.0000i
  -2.3333 + 0.0000i
  -0.4635 + 0.1997i
  -0.4635 - 0.1997i


z =

   0.0000 + 0.0000i
   1.2051 + 2.0872i
   1.2051 - 2.0872i
  -2.4101 + 0.0000i
  -1.0000 + 0.0000i
  -1.0000 - 0.0000i
```

2.3

```
z=5;
sys1=tf(20/z*[1 z],[1 3 20]);
z=10;
sys2=tf(20/z*[1 z],[1 3 20]);
z=15;
sys3=tf(20/z*[1 z],[1 3 20]);


t = [0:0.01:5];
y1=step(sys1,t);
y2=step(sys2,t);
y3=step(sys3,t);
plot(t,y1,t,y2,t,y3),grid
xlabel('second');
ylabel('output');
title('blue for 5, red for 10, yellow for 15');
```



2.4

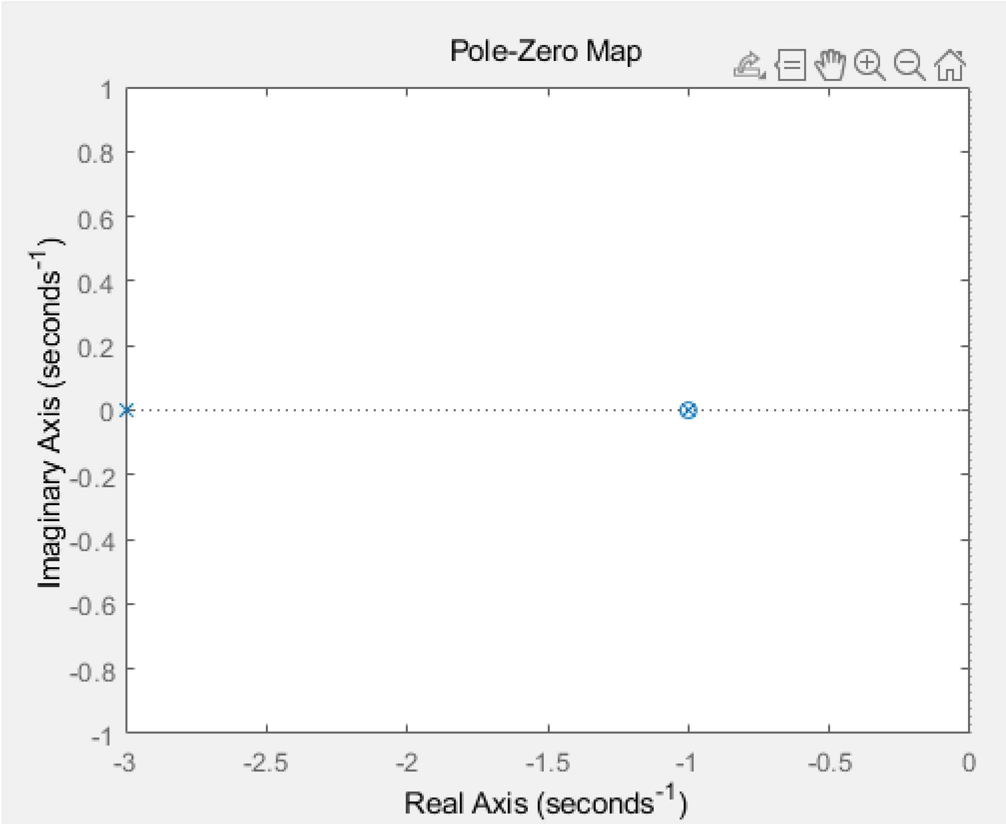
- 第一问

```
g=tf([1,1],[1,2]);
h=tf([1],[1,1]);
sys=feedback(g,h,-1)
```

```
sys =

  s^2 + 2 s + 1
  -------------
  s^2 + 4 s + 3

Continuous-time transfer function.
```

- 第二问：极点为-3、-1，零点为-1、-1

```
pzmap(sys)
p=pole(sys)
z=zero(sys)
```



- 第三问：有，一个-1可以对消

```
sys=minreal(sys)
```

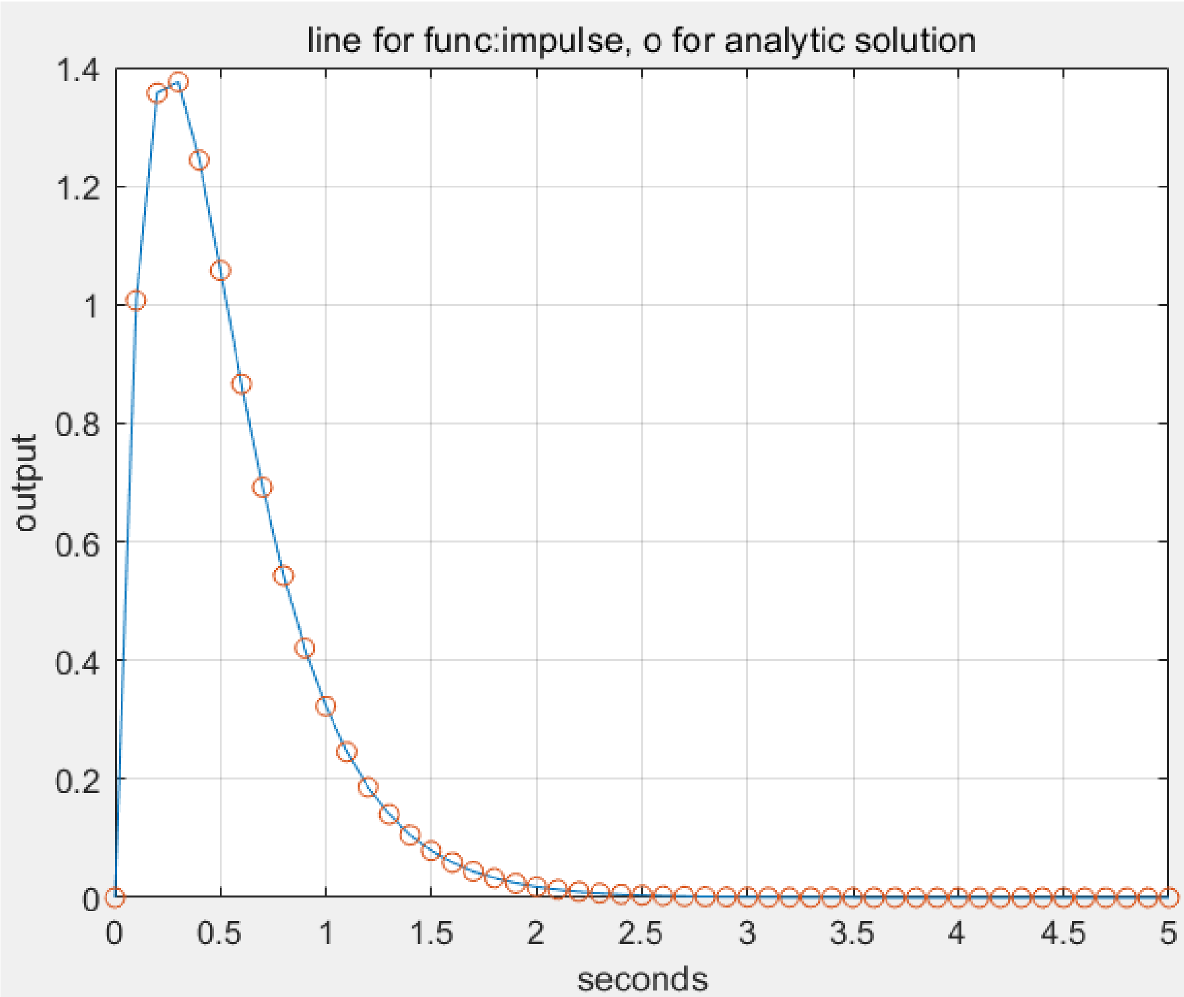
```
sys =

  s + 1
  -----
  s + 3

Continuous-time transfer function.
```

- 第四问：可以降低计算量，同时避免对于冗余极点、零点的特殊处理。

5.1

- $R(s) = 1, Y(s) = \frac{15}{(s+3)(s+5)}$，由拉普拉斯反变换得$y(t) = \frac{15}{2}e^{-3t} - \frac{15}{2}e^{-5t}$

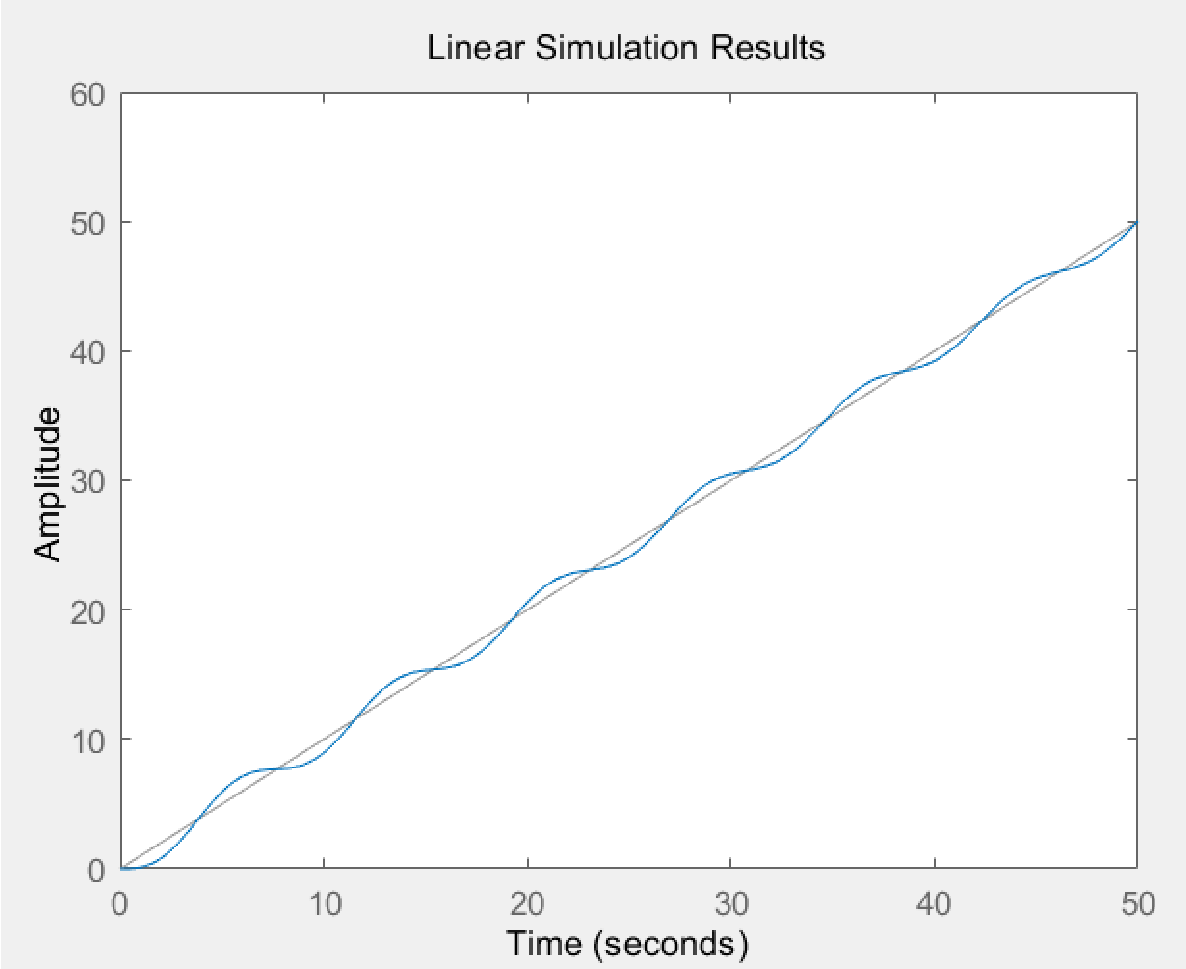
```
sys=tf([15],[1,8,15]);
t=[0:0.1:5];
y1 = impulse(sys,t);
y2 = 15/2*exp(-3*t)-15/2*exp(-5*t);
plot(t,y1,t,y2,'o'),grid
xlabel('seconds')
ylabel('output')
title('line for func:impulse, o for analytic solution');
```



5.2

- 稳态误差$e_{ss} = \frac{\epsilon_{ss}}{H(0)} = \lim_{s\to 0} \frac{1}{H(0)} \cdot \frac{sX_i(s)}{1+G(s)H(s)} = \lim_{s\to 0} \frac{s}{s^2+\frac{s+10}{s+15}} = \lim_{s\to 0} \frac{s}{10/15} = 0$

```
G=tf([1,10],[1,15,0,0]);
sys = feedback(G,[1],-1);
t = [0:0.1:50];
lsim(sys,t,t)
```

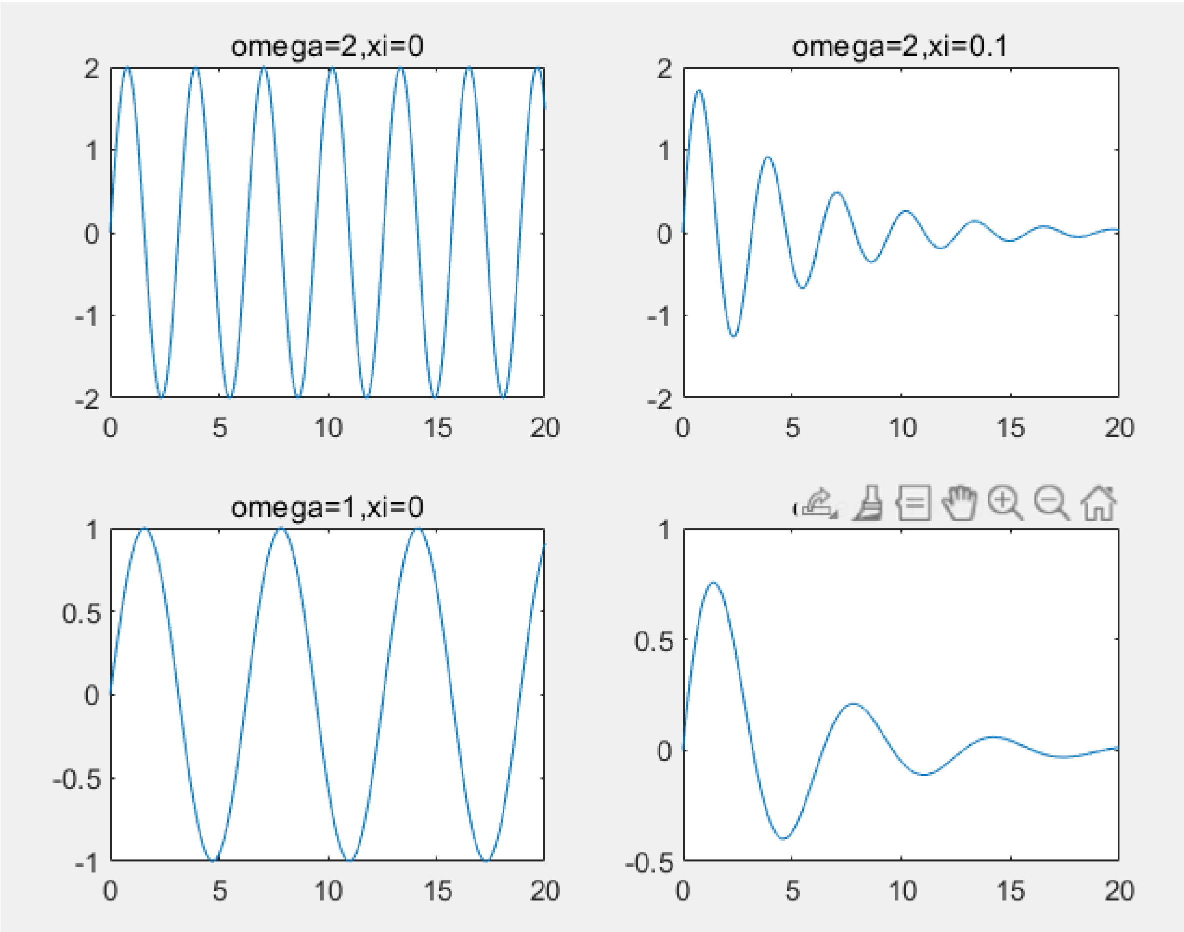


5.3

- 与5.17中的曲线加以比较
    - 图1中极点位于虚轴上，故呈现出幅度不变的周期函数
    - 图2中极点位于复平面第二象限，故呈现出振幅逐渐减小
    - 图3中极点位于虚轴上且更加靠近坐标原点，故幅度不变但相比1周期更长
    - 图4中极点位于复平面第二象限，但是在实部不变的情况下更靠近实轴，因此相比2震荡周期更长

```
t=[0:0.01:20];

omega=2;xi=0;
sys=tf(omega*omega,[1,2*xi*omega,omega*omega]);
pole(sys)
y=impulse(sys,t);
subplot(221),plot(t,y),title('omega=2,xi=0')

omega=2;xi=0.1;
sys=tf(omega*omega,[1,2*xi*omega,omega*omega]);
pole(sys)
y=impulse(sys,t);
subplot(222),plot(t,y),title('omega=2,xi=0.1')
```

```
omega=1;xi=0;
sys=tf(omega*omega,[1,2*xi*omega,omega*omega]);
pole(sys)
y=impulse(sys,t);
subplot(223),plot(t,y),title('omega=1,xi=0')

omega=1;xi=0.2;
sys=tf(omega*omega,[1,2*xi*omega,omega*omega]);
pole(sys)
y=impulse(sys,t);
subplot(224),plot(t,y),title('omega=1,xi=0.2')
```



```
ans =

   0.0000 + 2.0000i
   0.0000 - 2.0000i


ans =

  -0.2000 + 1.9900i
  -0.2000 - 1.9900i


ans =

   0.0000 + 1.0000i
   0.0000 - 1.0000i


ans =

  -0.2000 + 0.9798i
  -0.2000 - 0.9798i
```

5.4

- 第一问：

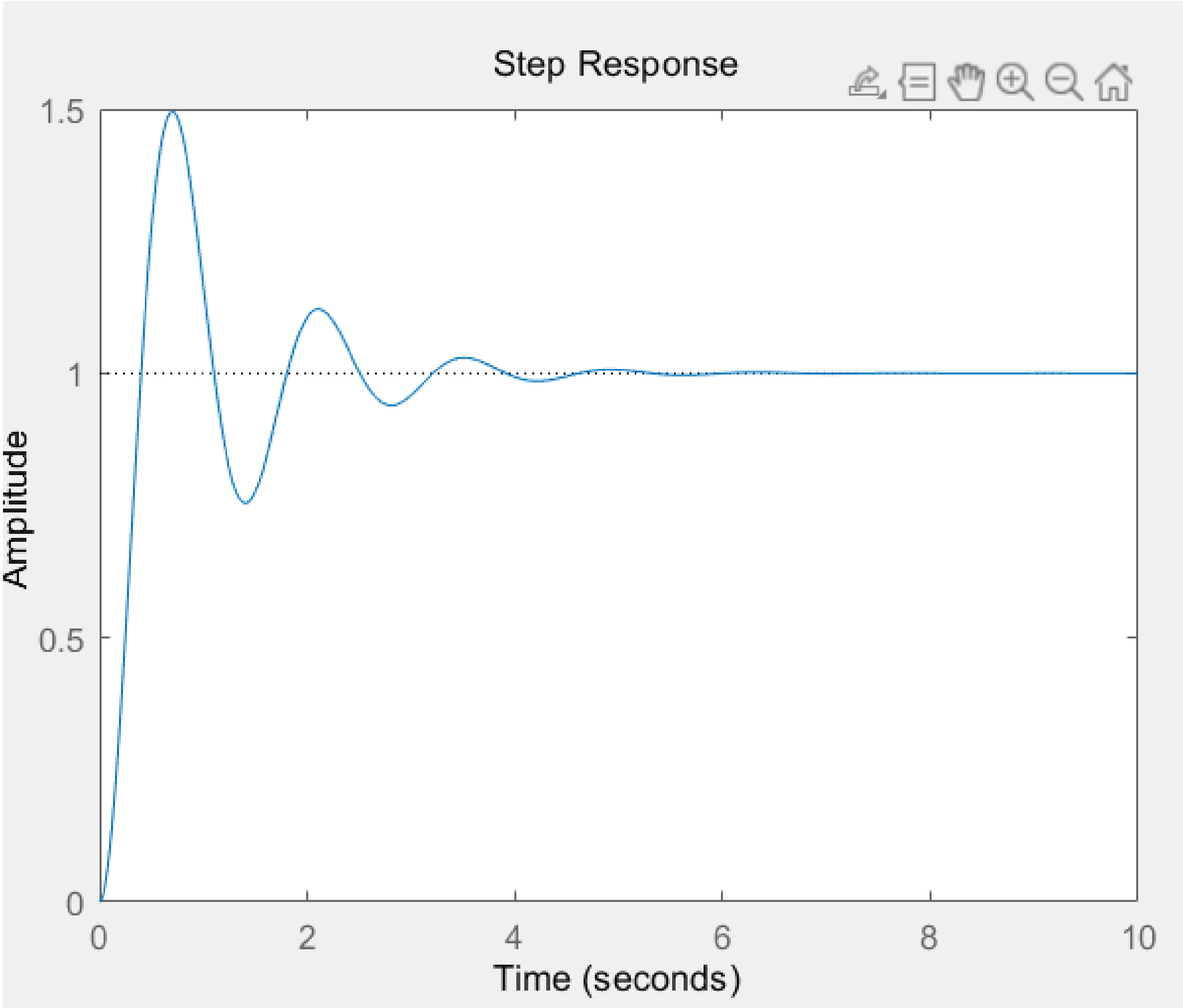
  $\frac{Y(s)}{R(s)} = \frac{21}{s^2+2s+21}$

  $\therefore \omega_n = \sqrt{21}, \xi = \frac{2}{\sqrt{21}}$

  $\therefore P.O. = e^{-\pi\xi\sqrt{1-\xi}} \approx 50\%$

- 第二问：由图像观察可得，超调量约为50%，与第一问结果相同

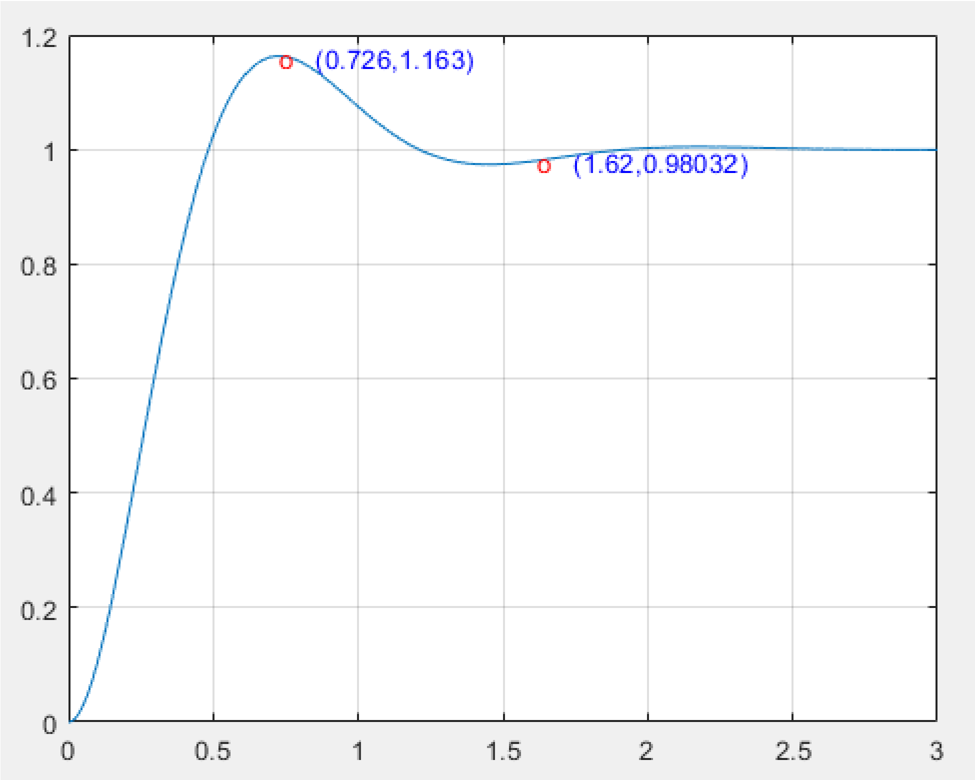
```
sys1=tf(1,[1,2]);
sys2=tf(21,[1,0]);
sys=series(sys1,sys2);
sys=feedback(sys,1,-1);
t=[0:0.01:10];
step(sys,t)
```



5.5

- 绘图如下，经过计算可得：$M_{pt} = 0.163, T_p = 0.726, T_s = 1.62$

```
L=tf(25,[1,5,0]);
sys=feedback(L,1,-1);
t=[0:0.001:3];
y = step(sys,t);
plot(t,y),grid

p=find(y==max(y));
Tp=t(p)
Mpt=(y(p)-1)/1
text(t(p),y(p),'o','color','red')
text(t(p),y(p),['     (',num2str(t(p)),',',num2str(y(p)),')'],'color','b')

p=find(abs(t-1.62)<1e-4);
text(t(p),y(p),'o','color','red')
text(t(p),y(p),['     (',num2str(t(p)),',',num2str(y(p)),')'],'color','b')
```



5.6

- 第一问

```
sys1=tf([0.5,2],[1,0])
sys2=tf(1,[1,2,0])
sys=series(sys1,sys2)
sys=feedback(sys,1,-1)
```

```
sys =

         0.5 s + 2
  ----------------------
  s^3 + 2 s^2 + 0.5 s + 2

Continuous-time transfer function.
```

- 第二问：经过观察发现为发散震荡，选取模拟信号输入范围为[0,100]，以较好的反映这种发散性质。

```
sys1=tf([0.5,2],[1,0])
sys2=tf(1,[1,2,0])
sys=series(sys1,sys2)
sys=feedback(sys,1,-1)
t=[0:0.1:100]
subplot(311),impulse(sys,t)
subplot(312),step(sys,t)
subplot(313),lsim(sys,t,t)
```