教科書１３章　１６４～１６７ページ

１３．１．２　設計例１と設計例２のプログラムを MATLAB で作成した．これらを以下に示す．

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１）設計例１

```matlab
%% 13．1節　設計例1
% sec13_1_example1.m  M. Saeki, May 2014
% 古典制御による設計
clear all
close all
%
s=tf('s');
sysP=1/(s*s*(s+1));
N=300;
w=logspace(-2,1,N);
M=200;
t=linspace(0,40,M);

%% KPの設計
[gainP,phaseP]=bode(sysP,w);
figure(1)
subplot(2,1,1)
semilogx(w,20*log10(gainP(:)),'LineWidth',2)
hold on
subplot(2,1,2)
semilogx(w,phaseP(:),'LineWidth',2)
hold on
%
%KP1=0.1
KP1=1
sysP1=KP1*sysP;
[gainP1,phaseP1]=bode(sysP1,w);
figure(1)
```

```matlab
subplot(2,1,1)
semilogx(w,20*log10(gainP1(:)),'LineWidth',1)
set(gca,'YTick',[ -80 -40  0  40  80]);
%axis([0.01,100,-80,20])
xlabel('¥omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Gain[dB]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
subplot(2,1,2)
semilogx(w,phaseP1(:),'LineWidth',1)
set(gca,'YTick',[ -270 -225 -180 -135 -90 0]);
%axis([0.01, 100, -270,10])
xlabel('¥omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Phase[deg]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid

%% 位相進みの設計
wmax=0.3
pmax=60*pi/180
T1=sqrt((1-sin(pmax))/(1+sin(pmax)))/wmax;
T2=sqrt((1+sin(pmax))/(1-sin(pmax)))/wmax;
K1=(1+s*T2)/(1+s*T1)
sysP2=sysP*K1

[gainP2,phaseP2]=bode(sysP2,w);
figure(1)
subplot(2,1,1)
semilogx(w,20*log10(gainP2(:)),'--','LineWidth',2)
hold on
subplot(2,1,2)
semilogx(w,phaseP2(:),'--','LineWidth',2)
hold on
%
```

```matlab
sysP22=sysP*(10^(-32/20))*K1;
[gainP22,phaseP22]=bode(sysP22,w);
figure(2)
subplot(2,1,1)
semilogx(w,20*log10(gainP2(:)),w,20*log10(gainP22(:)),'LineWidth',1)
%set(gca,'YTick',[-100 -80 -60 -40 -20 0 20 40 60 80 100]);
set(gca,'YTick',[ -80 -40  0  40  80]);
%axis([0.01,100,-80,40])
xlabel('¥omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Gain[dB]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
%grid
subplot(2,1,2)
semilogx(w,phaseP2(:),w,phaseP22(:),'LineWidth',1)
set(gca,'YTick',[ -270 -225 -180 -135 -90 0]);
%axis([0.01, 100, -360,10])
xlabel('¥omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Phase[deg]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
%grid
%
sysT22=feedback(sysP22,1);
figure(3)
y22=step(sysT22,t);
plot(t,y22(:),'LineWidth',2)
%set(gca,'YTick',[-360 -270 -180 -130 -90 0]);
%axis([0.01, 100, -360,10])
ylabel('y(t)','FontSize',16,'FontName','Times New Roman')
xlabel('t[s]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
```

設計例２）

```matlab
%% 13.2節　例題2
%  sec13_1_example2.m  M. Saeki May 2014
%  古典制御の設計
clear all
close all
%
s=tf('s');
sysP=1/((s+2)*(s+1));
sysL1=sysP/s;
N=300;
w=logspace(-2,1,N);
M=200;
t=linspace(0,20,M);


%% KI/sの設計
[gainL1,phaseL1]=bode(sysL1,w);
figure(1)
subplot(2,1,1)
semilogx(w,20*log10(gainL1(:)),'LineWidth',2)
hold on
grid
subplot(2,1,2)
semilogx(w,phaseL1(:),'LineWidth',2)
hold on
grid
%
%% 位相進みの設計
wmax=2
pmax=60*pi/180
T1=sqrt((1-sin(pmax))/(1+sin(pmax)))/wmax;
T2=sqrt((1+sin(pmax))/(1-sin(pmax)))/wmax;
K1=(1+s*T2)/(1+s*T1)
sysL2=sysL1*K1


[gainL2,phaseL2]=bode(sysL2,w);
```

```matlab
figure(1)
subplot(2,1,1)
semilogx(w,20*log10(gainL2(:)),'--','LineWidth',2)
hold on
subplot(2,1,2)
semilogx(w,phaseL2(:),'--','LineWidth',2)
hold on
%
sysL22=sysL2*(10^(10/20));
[gainL22,phaseL22]=bode(sysL22,w);
figure(2)
subplot(2,1,1)
semilogx(w,20*log10(gainL22(:)),w,20*log10(gainL22(:)),'LineWidth',1)
%set(gca,'YTick',[-100 -80 -60 -40 -20 0 20 40 60 80 100]);
set(gca,'YTick',[ -80 -40  0  40  80]);
%axis([0.01,100,-80,40])
xlabel('¥omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Gain[dB]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
subplot(2,1,2)
semilogx(w,phaseL22(:),w,phaseL22(:),'LineWidth',1)
set(gca,'YTick',[ -270 -225 -180 -135 -90 0]);
%axis([0.01,  100,  -360,10])
xlabel('¥omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Phase[deg]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
%% 位相遅れの設計
T4=10
T3=3*T4
K2=(1+s*T4)*T3/((1+s*T3)*T4)
sysL3=sysL22*K2
```

```matlab
[gainL3,phaseL3]=bode(sysL3,w);
figure(3)
subplot(2,1,1)
semilogx(w,20*log10(gainL22(:)),'LineWidth',2)
hold on
subplot(2,1,2)
semilogx(w,phaseL22(:),'LineWidth',2)
hold on


figure(3)
subplot(2,1,1)
semilogx(w,20*log10(gainL3(:)),'--','LineWidth',2)
%set(gca,'YTick',[-100 -80 -60 -40 -20 0 20 40 60 80 100]);
set(gca,'YTick',[ -80 -40  0  40  80]);
%axis([0.01,100,-80,40])
xlabel('\omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Gain[dB]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
subplot(2,1,2)
semilogx(w,phaseL3(:),'--','LineWidth',2)
set(gca,'YTick',[ -270 -225 -180 -135 -90 0]);
%axis([0.01, 100, -360,10])
xlabel('\omega [rad/s]','FontSize',16,'FontName','Times New Roman')
ylabel('Phase[deg]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
%
sysT22=feedback(sysL3,1);
figure(4)
y22=step(sysT22,t);
plot(t,y22(:),'LineWidth',2)
%set(gca,'YTick',[-360 -270 -180 -130 -90 0]);
```

```matlab
%axis([0.01, 100, -360,10])
ylabel('y(t)','FontSize',16,'FontName','Times New Roman')
xlabel('t[s]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid

figure(5)
y23=step(sysT22/s,t);
for i=1:length(t)
    y24(i)=t(i);
end
plot(t,y23(:),t,y24,'LineWidth',2)
%set(gca,'YTick',[-360 -270 -180 -130 -90 0]);
%axis([0.01, 100, -360,10])
ylabel('y(t)','FontSize',16,'FontName','Times New Roman')
xlabel('t[s]','FontSize',16,'FontName','Times New Roman')
set(gca,'FontSize',16)
set(gca,'FontName','Times New Roman')
grid
```