

```
clc;
clear all;
close all;
```

```
run("Q310_Basic.mlx")
```

```
sys_dis_open =
```

$$\frac{0.1604 z^2 - 0.1958 z + 0.07861}{z^3 - 1.937 z^2 + 1.122 z - 0.1421}$$

```
Sample time: 0.24388 seconds
Discrete-time transfer function.
```

```
c = 1×4
    0    0.1604   -0.1958    0.0786
d = 1×4
    1.0000   -1.9367    1.1220   -0.1421
sys_cont_close =
```

$$\frac{7.8 s^3 + 205.7 s^2 + 601.4 s + 1276}{s^4 + 15.8 s^3 + 212.7 s^2 + 608.4 s + 1276}$$

```
Continuous-time transfer function.
```

```
sys_dis_close =
```

$$\frac{0.1328 z^3 - 0.3505 z^2 + 0.3048 z - 0.08705}{z^4 - 3.73 z^3 + 5.24 z^2 - 3.288 z + 0.778}$$

```
Sample time: 0.015887 seconds
Discrete-time transfer function.
```

```
c1 = 1×5
    0    0.1328   -0.3505    0.3048   -0.0871
d1 = 1×5
    1.0000   -3.7296    5.2395   -3.2878    0.7780
```

generate data

```
tfinal=500;
t = 0:T_s:tfinal;
u = gensig('sine' , tfinal/20 , tfinal ,T_s);

% t = 0:T_s_close:tfinal;
% u = gensig('sine' , tfinal/20 , tfinal ,T_s_close);

var_e=0.05;

e=sqrt(var_e);
Noise=(-e+(e+e)*rand(numel(t),1));
u=u+Noise;

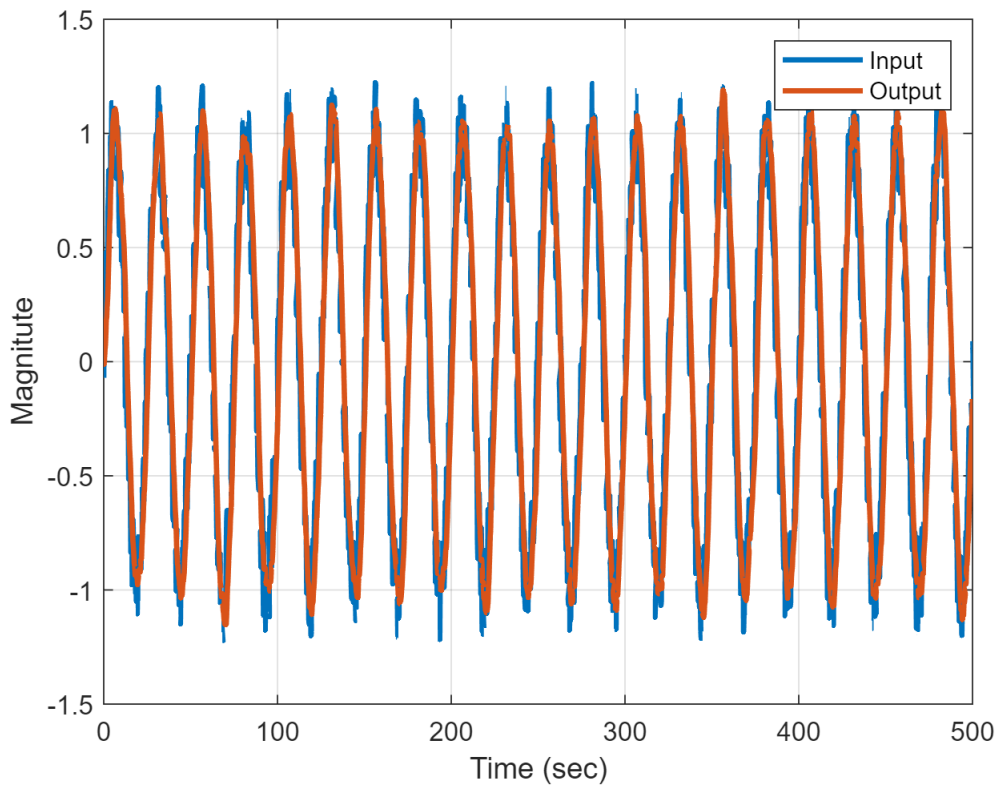
y = lsim(sys_dis_open ,u ,t);
plot(t,u ,t , y , 'LineWidth',2) ;
xlabel('Time (sec)') ;
```

```

ylabel('Magnitude') ;
grid on
legend('Input','Output') ;

% y = lsim(sys_dis_close ,u ,t);
% plot(t,u ,t , y ,'LineWidth',2) ;
% xlabel('Time (sec)') ;
% ylabel('Magnitude') ;
% grid on
legend('Input','Output') ;

```



Kalman Filter

```

N = numel(y) ;
% %-----%
%choose number of parameters
Parameters_in_den=3

Parameters_in_den = 3

Parameters_in_num=3

Parameters_in_num = 3

% %-----%
Nv=Parameters_in_num+Parameters_in_den;

p_KF(1:Nv,1:Nv,1:N)=zeros(Nv,Nv,N);

```

%intitial Conditions

```
theta_hat_KF(1:Nv,1:N)=zeros(Nv,N);  
K_KF(1:Nv,1:N)=zeros(Nv,N);  
var_e=0.05;
```

```
p_KF(1:Nv,1:Nv,1)=1e5*eye(Nv);p_KF(1:Nv,1:Nv,2)=p_KF(1:Nv,1:Nv,1);p_KF(1:Nv,1:Nv,3)=p_KF(1:Nv,1:Nv,1);
```

```
for i=(max(Parameters_in_num,Parameters_in_den)+1):N  
    phi_KF(:,i)=[(y(i-1:-1:i-Parameters_in_den))',(u(i-1:-1:i-Parameters_in_num)))']';  
    K_KF(:,i) =p_KF(:, :, i-1)*phi_KF(:,i)*(1+phi_KF(:,i)'*p_KF(:, :, i-1)*phi_KF(:,i))^-1) ;  
    p_KF(:, :, i)=p_KF(:, :, i-1)-p_KF(:, :, i-1)*phi_KF(:,i)*(1+phi_KF(:,i)'*p_KF(:, :, i-1)*phi_KF(:,i))^-1);  
    theta_hat_KF(:,i)=theta_hat_KF(:,i-1)+K_KF(:,i)*(y(i)-phi_KF(:,i)'*theta_hat_KF(:,i-1));  
end
```

Bode

```
ident_dis = tf(theta_hat_KF((Parameters_in_num+1):end,end)',[1 -theta_hat_KF(1:Parameters_in_den,end)])
```

```
ident_dis =
```

$$\frac{0.1604 z^2 - 0.1957 z + 0.07843}{z^3 - 1.936 z^2 + 1.12 z - 0.1413}$$

Sample time: 0.24388 seconds
Discrete-time transfer function.

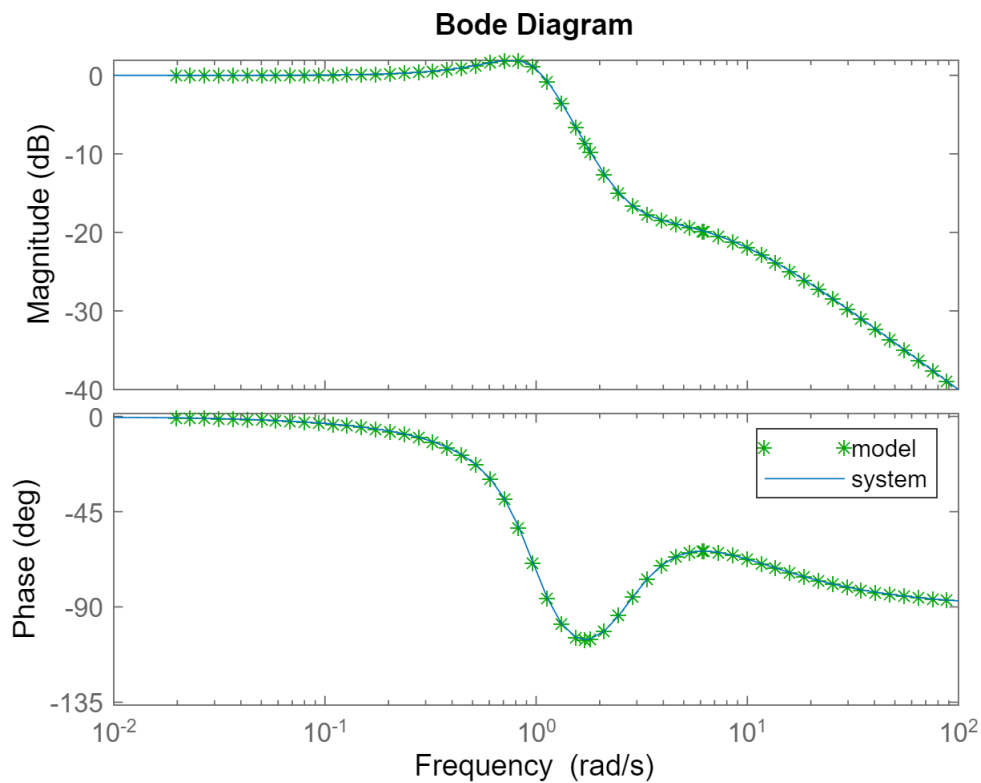
```
ident_analog = d2c(ident_dis)
```

```
ident_analog =
```

$$\frac{1.001 s^2 + 3.013 s + 7.01}{s^3 + 8.023 s^2 + 7.019 s + 7.01}$$

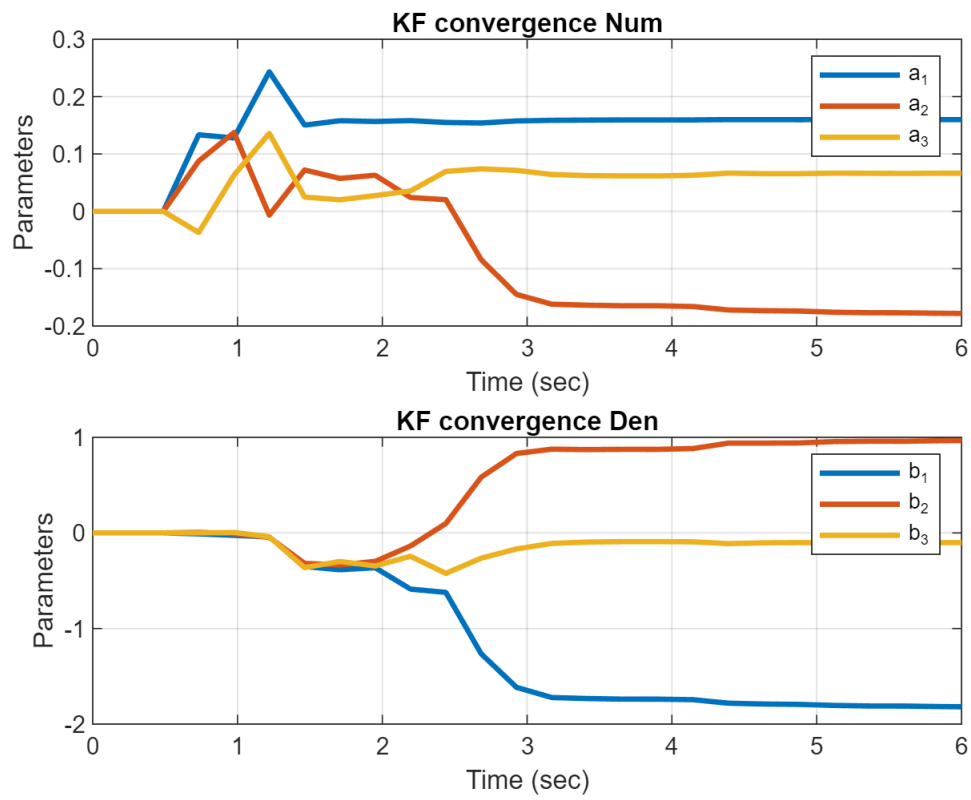
Continuous-time transfer function.

```
bode(ident_analog , 'g*', sys_cont_open )  
legend('model ', 'system')
```



KF Convergence

```
subplot(2,1,1)
plot(t , theta_hat_KF((Parameters_in_num+1):end,:)) , 'LineWidth' , 2) ;
xlabel('Time (sec)') ;
ylabel('Parameters') ;
title('KF convergence Num') ;
grid on
legend('a_1','a_2','a_3')
xlim([0 6])
% ylim([-1 1])
%-----
subplot(2,1,2)
plot(t , -theta_hat_KF(1:Parameters_in_num ,:)) , 'LineWidth' , 2) ;
xlabel('Time (sec)') ;
ylabel('Parameters') ;
title('KF convergence Den') ;
grid on
legend('b_1','b_2','b_3')
xlim([0 6])
```



```
% ylim([-7 7])
```