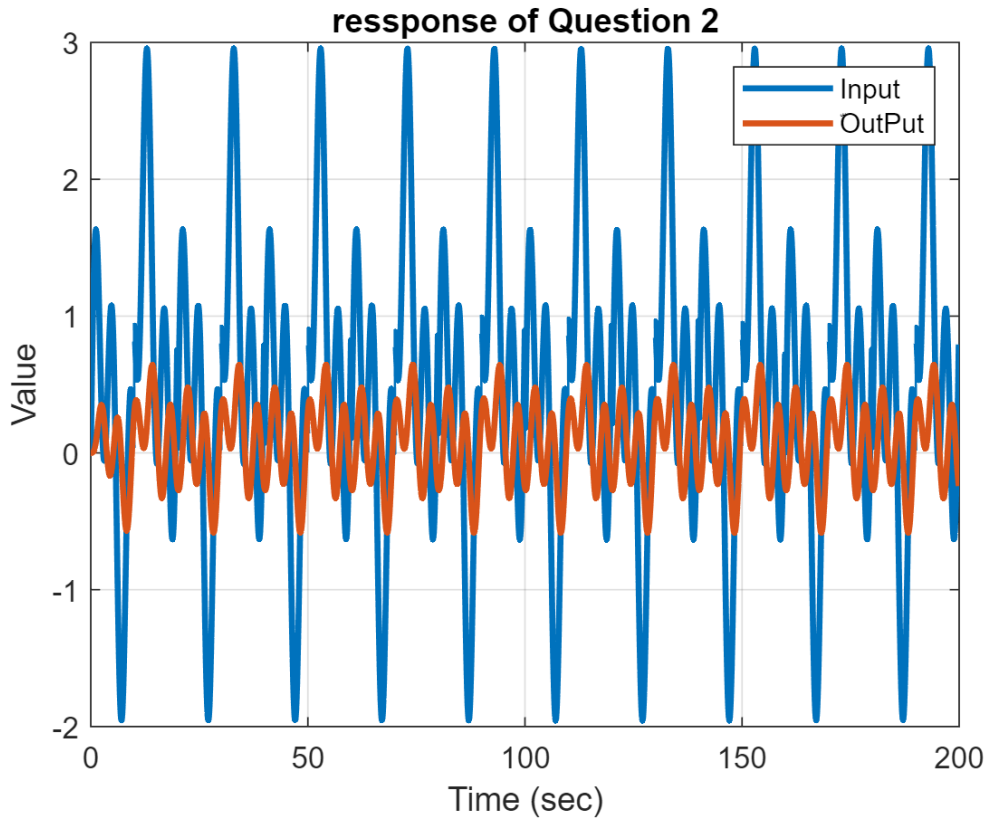
```
clc;
clear all;
close all;
```

generate data

```
run ("Basics.m")
```

```
sys =

                1.3 s + 1.333
  ------------------------------------------
  s^4 + 3.967 s^3 + 8.41 s^2 + 10.62 s + 8.756

Continuous-time transfer function.
fb = 2.4327
sysd =

  0.0004236 z^3 + 0.001167 z^2 - 0.000997 z - 0.0003069
  -----------------------------------------------------
      z^4 - 3.481 z^3 + 4.58 z^2 - 2.697 z + 0.5991

Sample time: 0.12914 seconds
Discrete-time transfer function.
c = 1×5
         0    0.0004    0.0012   -0.0010   -0.0003
d = 1×5
    1.0000   -3.4807    4.5802   -2.6968    0.5991
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
tfinal=200;
t = 0:T_s:tfinal;
u = gensig('sine' , tfinal/20 , tfinal ,T_s)+gensig('sine' , tfinal/50 , tfinal ,T_s)+gensig('s
y = lsim(sysd  ,u ,t);
plot(t,u ,t , y ,'LineWidth',2) ;
xlabel('Time (sec)') ;
ylabel('Value') ;
title('ressponse of Question 2') ;
grid on
legend('Input' , 'OutPut') ;
```



recursive least esquare estimation

```
N = numel(y) ;
%choose number of parameters
Parameters_in_den=6
```

```
Parameters_in_den = 6
```

```
Parameters_in_num=6
```

```
Parameters_in_num = 6
```

```
Nv=Parameters_in_num+Parameters_in_den
```

```
Nv = 12
```

```
% Nv = 10 ;
P = 1e12*eye(Nv) ;
theta=[Nv,N]
```

```
theta = 1×2
          12        1549
```

```
theta(1:Nv,1:20) =5*ones(Nv,20) ;

phi=[];
Eror=zeros(1,N)
```

```
Eror = 1×1549
```

```
     0     0     0     0     0     0     0     0     0     0     0     0     0···
```

```
tic
for i = (max(Parameters_in_num,Parameters_in_den))+1:N
    phi(:,i) = [[y(i-1:-1:i-Parameters_in_den)]' , [u(i-1:-1:i-Parameters_in_num)]'];
    K = P*phi(:,i)*(1+phi(:,i)'*P*phi(:,i))^(-1) ;
    P = (eye(Nv) - K*phi(:,i)')*P ;
    theta(:,i) = theta(:,i-1) + K*(y(i) - phi(:,i)'*theta(:,i-1));
    Eror(i)=(Eror(i-1)+(y(i)-phi(:,i)'*theta(:,i))^2);
end
toc
```

```
Elapsed time is 0.031647 seconds.
```

Bode

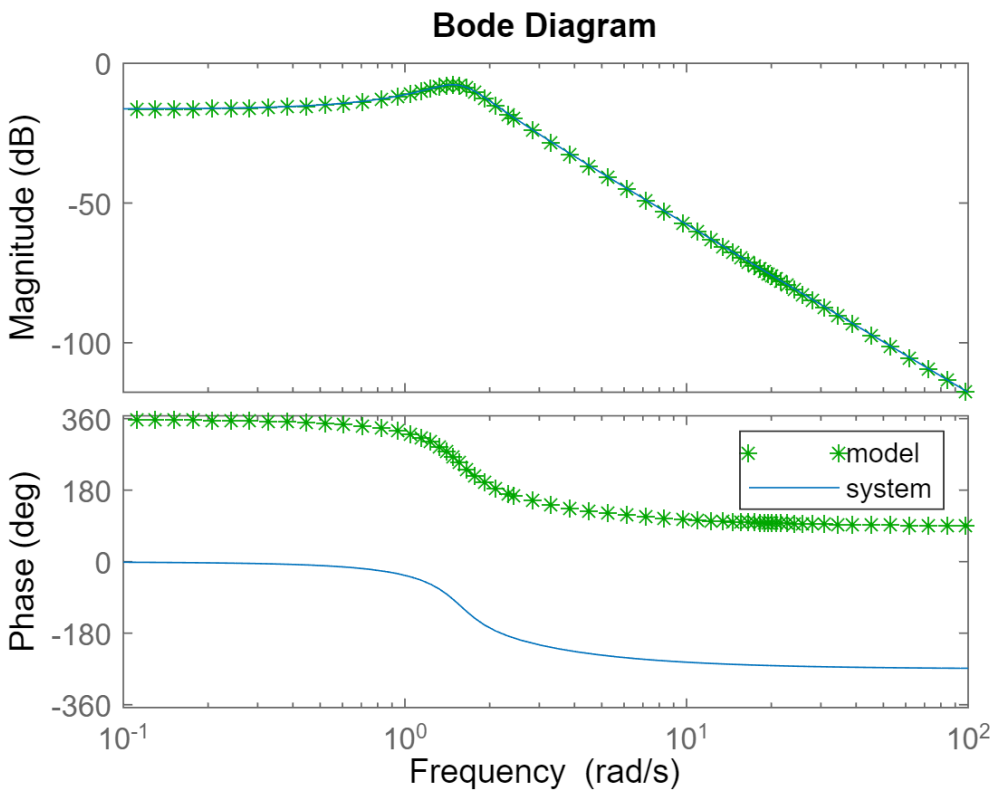
```
ident_dis = tf(theta((Parameters_in_num+1):end,end)' ,[1 -theta(1:Parameters_in_num ,end)'], T_
```

```
ident_dis =

  0.0004236 z^5 + 0.001732 z^4 + 0.0008411 z^3 - 0.0008585 z^2 - 0.001073 z - 0.0002044
  ---------------------------------------------------------------------------------------
        z^6 - 2.148 z^5 + 0.6061 z^4 + 1.091 z^3 + 0.0551 z^2 - 0.9977 z + 0.3991

Sample time: 0.12914 seconds
Discrete-time transfer function.
```

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

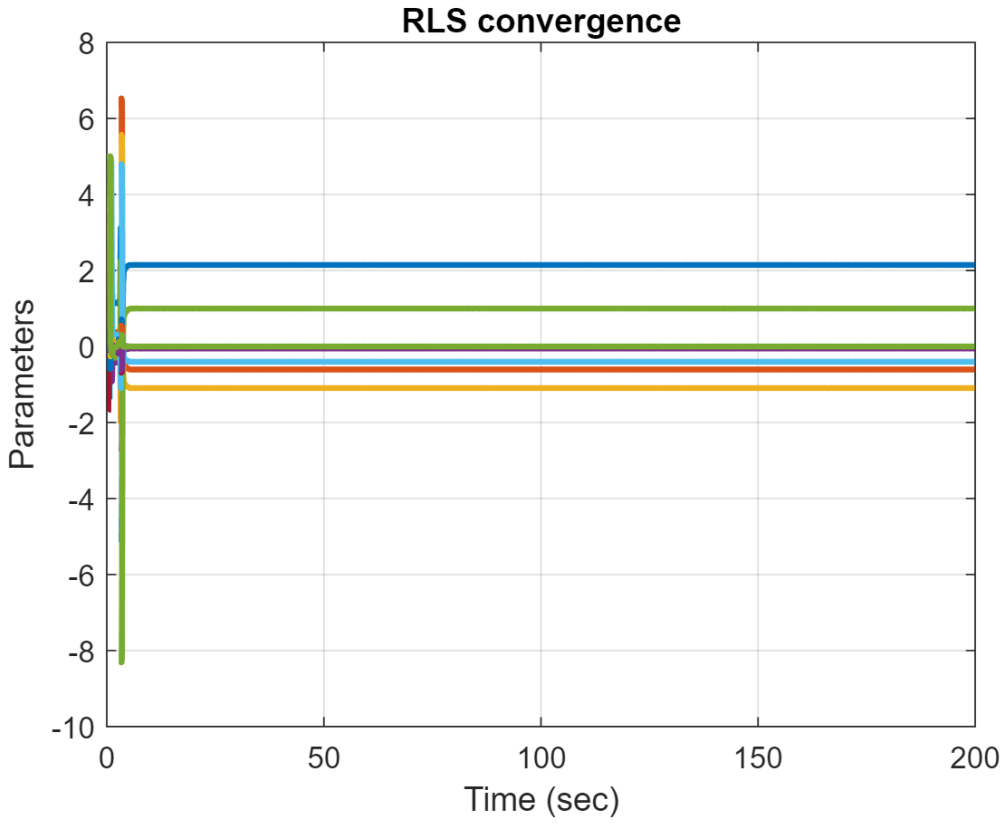
```
ident_analog =

  2.648e-10 s^5 - 2.884e-09 s^4 + 1.3 s^3 + 5.423 s^2 + 505 s + 513.6
  ------------------------------------------------------------------
   s^6 + 7.112 s^5 + 406.1 s^4 + 1565 s^3 + 3282 s^2 + 4120 s + 3373

Continuous-time transfer function.
```

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

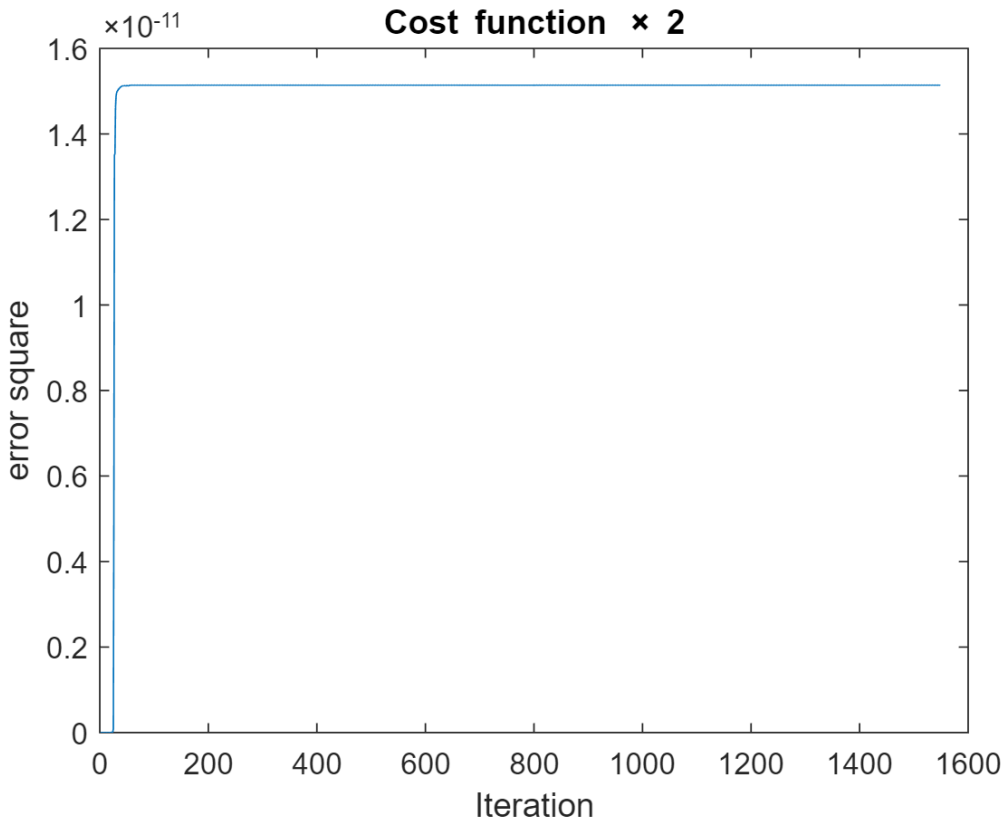


RLS Convergence

```
plot(t , theta(:,:) , 'LineWidth' , 2) ;
xlabel('Time (sec)') ;
ylabel('Parameters') ;
title('RLS convergence') ;
grid on
```




```
plot(1:1:N,Eror)
xlabel('Iteration') ;
ylabel('error square') ;
title('Cost function \times 2') ;
```


Cost function × 2
×10-11
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
error square
0
200
400
600
800
1000
1200
1400
1600
Iteration