THE UNIVERSITY OF TEXAS AT ARLINGTON, TEXAS
DEPARTMENT OF ELECTRICAL ENGINEERING

EE 5327 - 001

SYSTEM IDENTIFICATION & ESTIMATION

HW # 3
ASSIGNMENT

by

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Presented to

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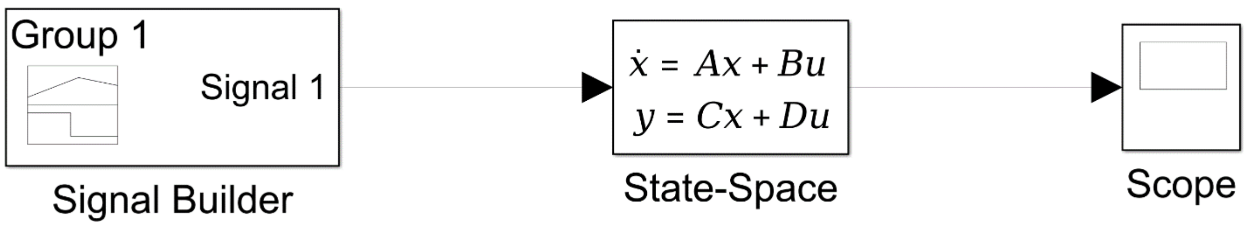
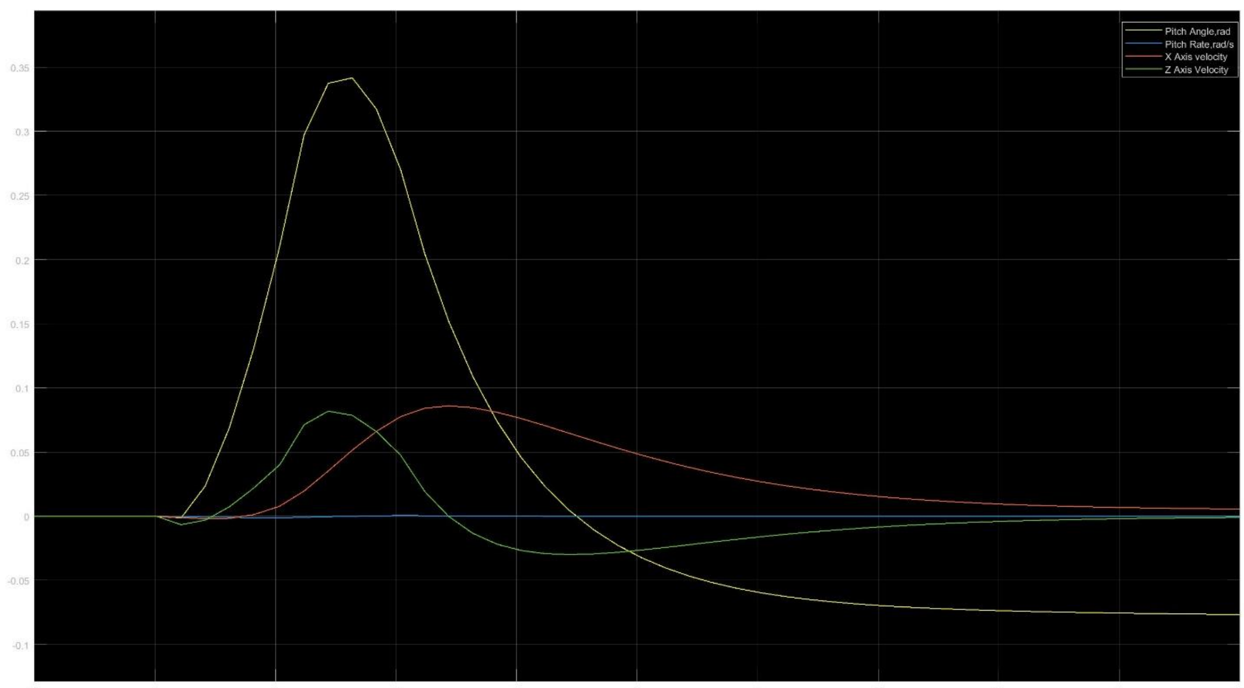
Problem 1:

a)

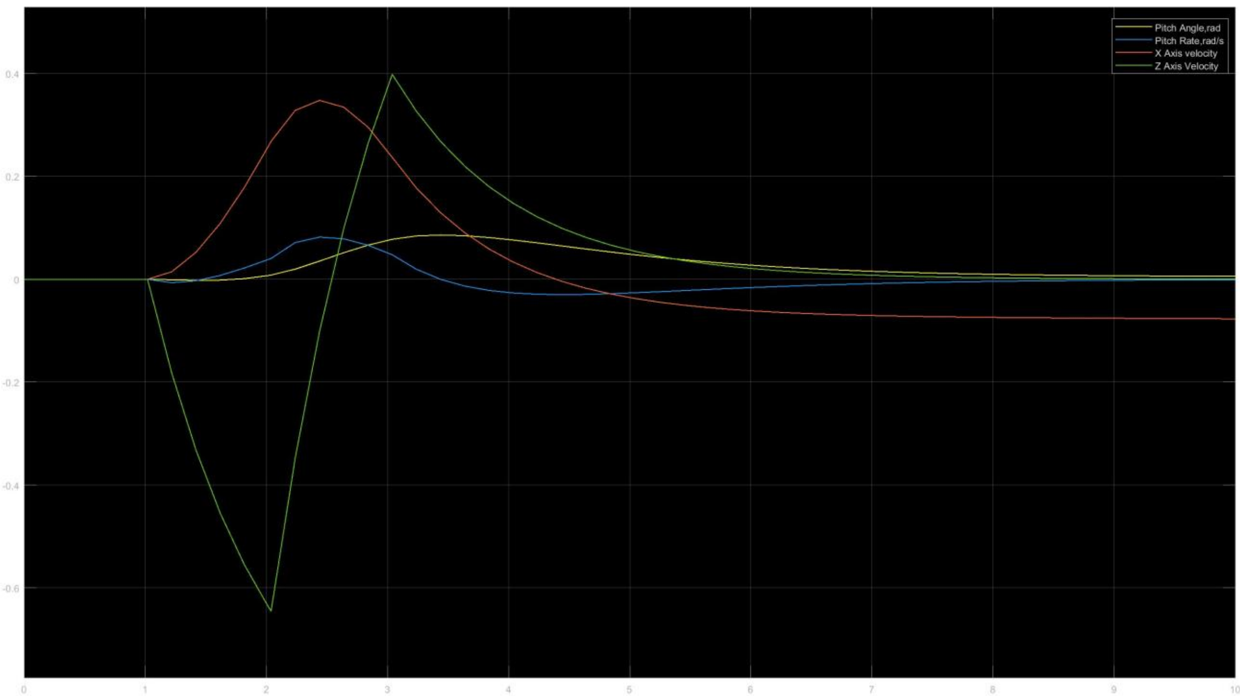
Simulink Diagram for aircraft dynamics



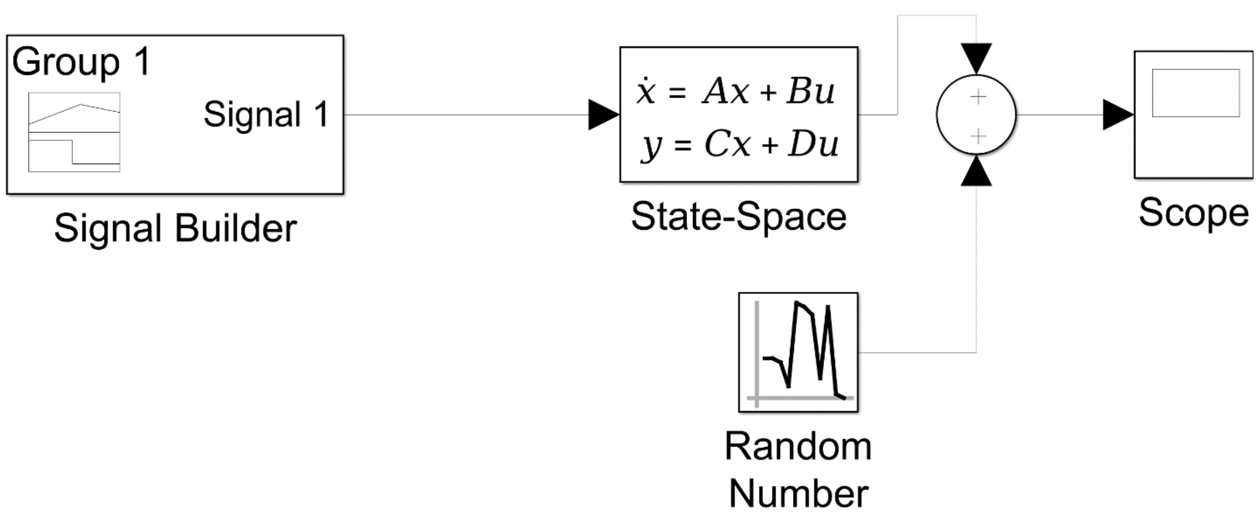
Output response



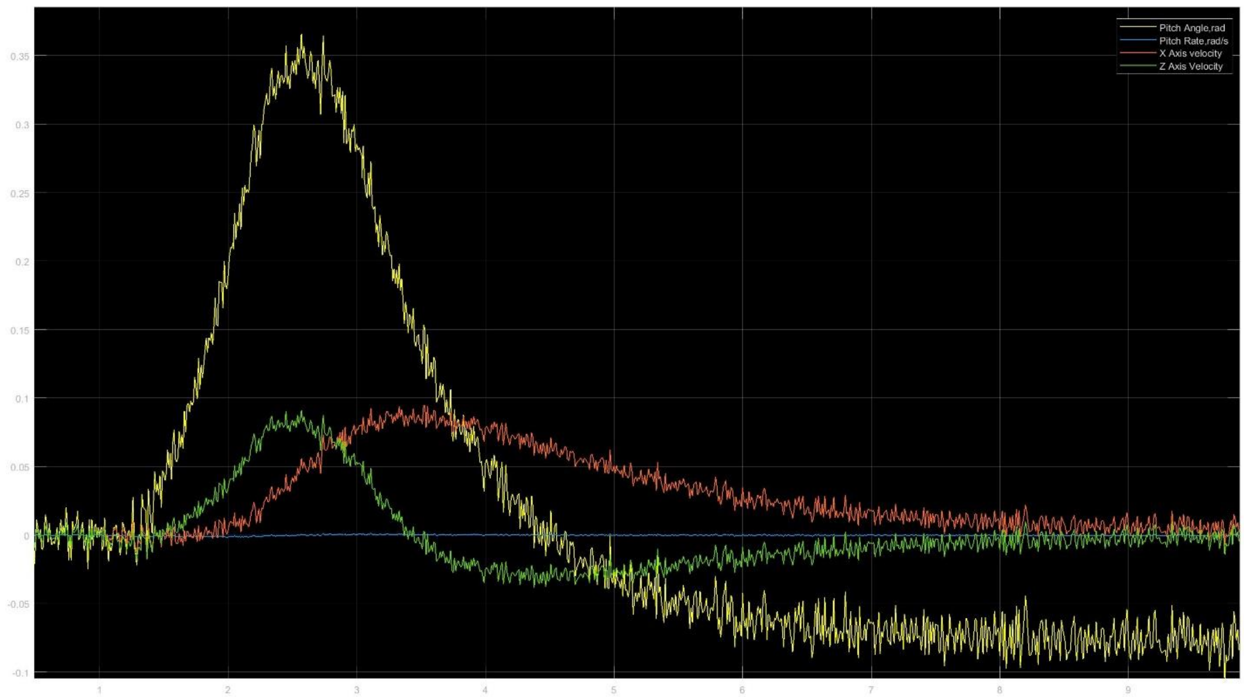
States response



b) Block diagram for adding noise to outputs



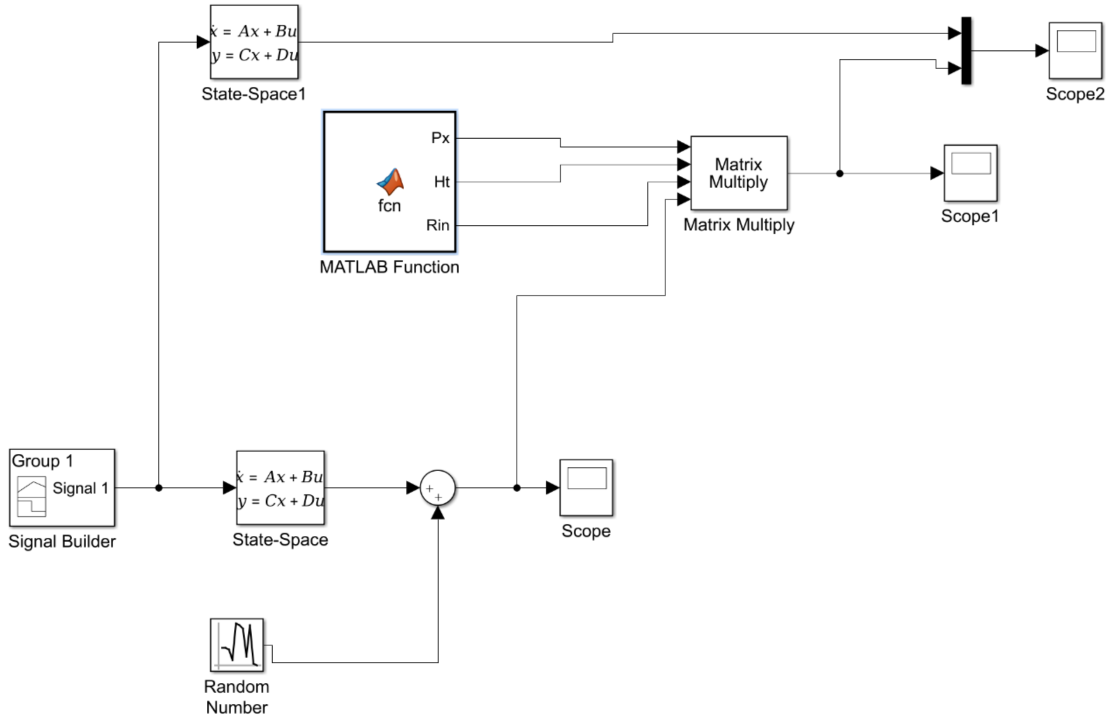
Response after adding noise to the outputs.



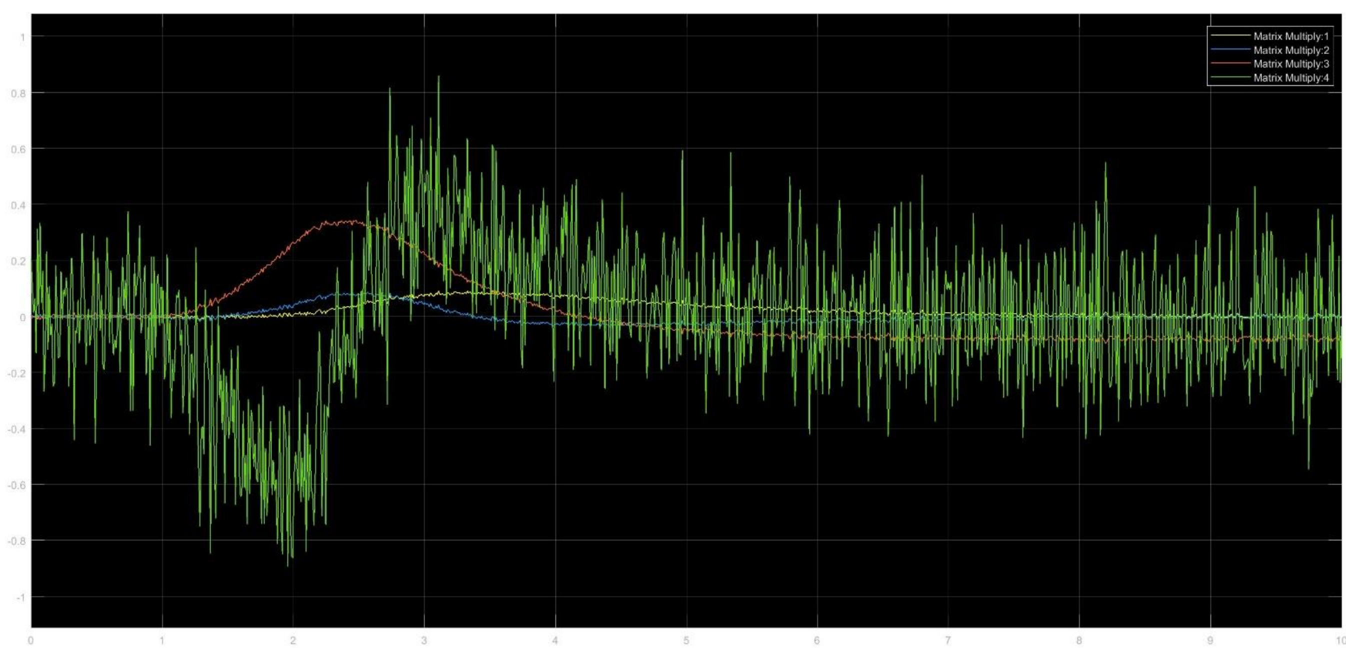
c) MLE function –

```
function [Px,Ht,Rin] = fcn
a =[0 1.0000 0 0;
0 -0.9965 0 -0.3000;
-0.3197 -0.5176 -0.0100 -0.7000;
0 0 -0.0005 -0.9924];


c =[0 0 0.9963 0.0862;
0 0 -0.0001 0.0017;
1.0000 0 0 0;
0 1.0000 0 0];

cov=[0.0001, 0.0000001, 0.00002, 0.00002];

R=diag(cov);
Rin=inv(R);
H=c;
Ht=H';
Px=inv(Ht*Rin*H);
```

MLE function block in simulink

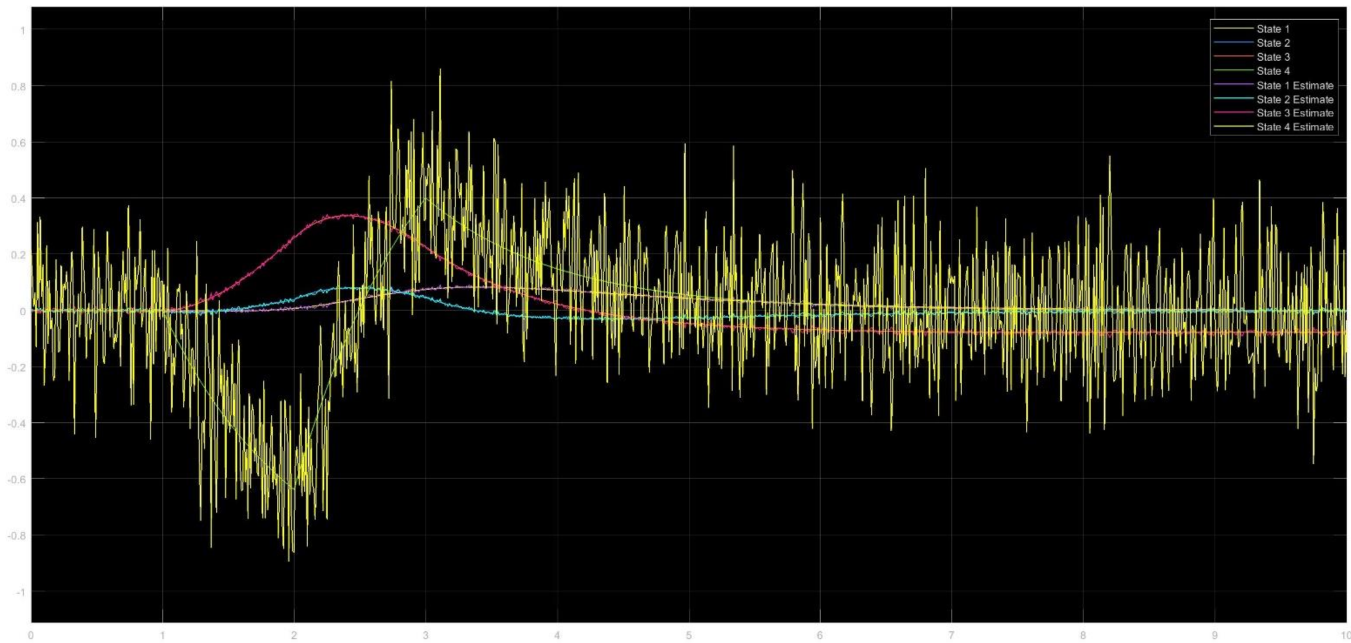


Estimated states due to MLE

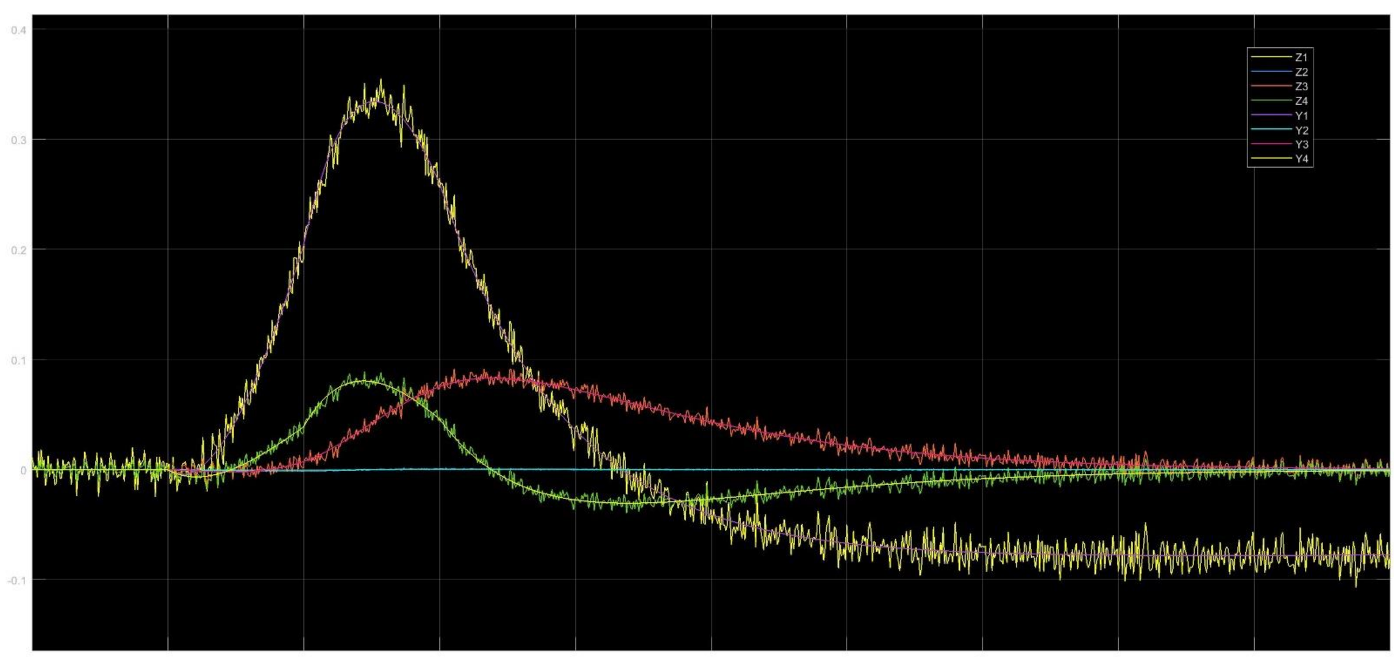


d)

Estimated states and the actual states

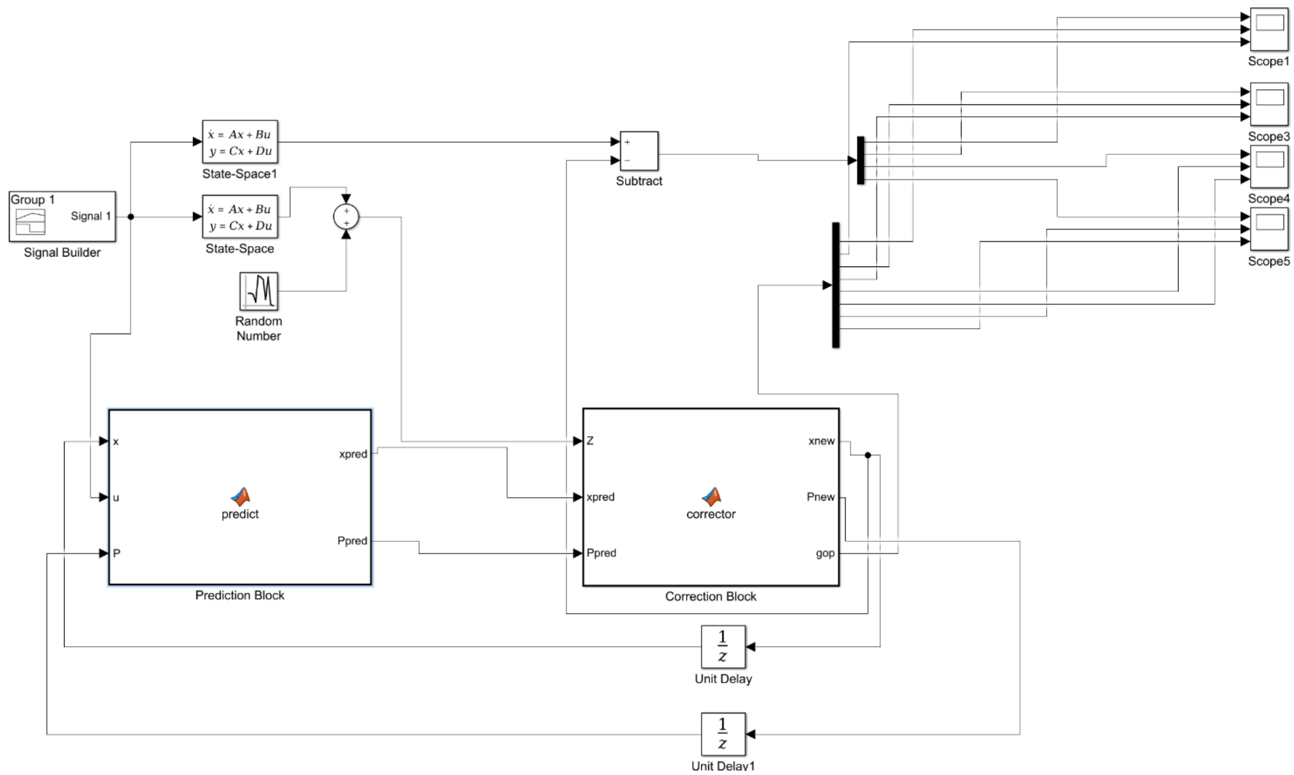


Outputs Y and measurements Z



Problem 2 :

e) Block Diagram for DKF.



Predictor Block –

```
function [xpred, Ppred] = predict(x, u, P)
%xpred= A*x+B*U;
%Ppred=A*P*A'+Q;
xpred=zeros(4,1);
Ppred=zeros(4);
b = [ 0;-0.0013;0.0001;-0.0201];
a =[0 1.0000 0 0;0 -0.9965 0 -0.3000;-0.3197 -0.5176 -0.0100 -0.7000;0
0 -0.0005 -0.9924];
Q =100*eye(4);
P=eye(4);
Ad=expm(a*0.01);
Bd=inv(a)*(Ad-eye(4))*b;
F=[-a Q;zeros(4,4) a'];
G=expm(F*0.01);
GLr=G(5:8,5:8);
Gur=G(1:4,5:8);
Qd=GLr'*Gur;
```

```
xpred=Ad*x+Bd*u;
Ppred=Ad*P*Ad'+Qd;
```

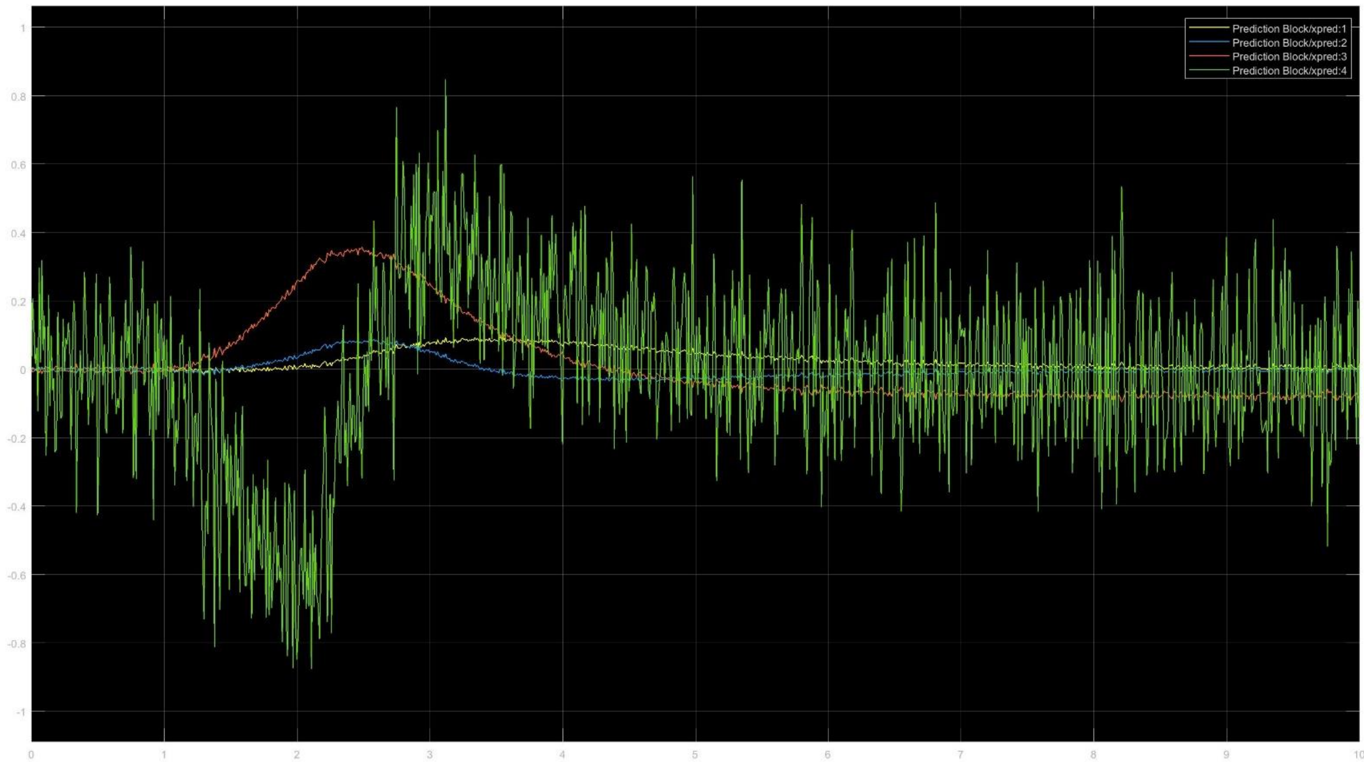
Corrector Block –

```
function [xnew, Pnew,gop] = corrector(Z,xpred,Ppred)
%xpred= A*x+B*U;
%Ppred=A*P*A'+Q;
xnew=zeros(4,1);
Pnew=zeros(4);
gop=zeros(8,1);
R=diag([0.0001, 0.0000001, 0.00002, 0.00002]);
c = [0 0 0.9963 0.0862;
0 0 -0.0001 0.0017;
1.0000 0 0 0;
0 1.0000 0 0];
H=c;
K=Ppred*transpose(H)*inv(H*Ppred*(H)'+R);
Pnew=((eye(4)-K*H)*Ppred*transpose(eye(4)-K*H))+K*R*transpose(K);
xnew=xpred+K*(Z-H*xpred);

P44=Pnew(4,4)
gop(8,1)=sqrt(P44);
gop(7,1)=-sqrt(P44);
P33=Pnew(3,3)
gop(6,1)=sqrt(P33);
gop(5,1)=-sqrt(P33);
P22=Pnew(2,2)
gop(4,1)=sqrt(P22);
gop(3,1)=-sqrt(P22);
P11=Pnew(1,1)
gop(2,1)=sqrt(P11);
gop(1,1)=-sqrt(P11);

end
```

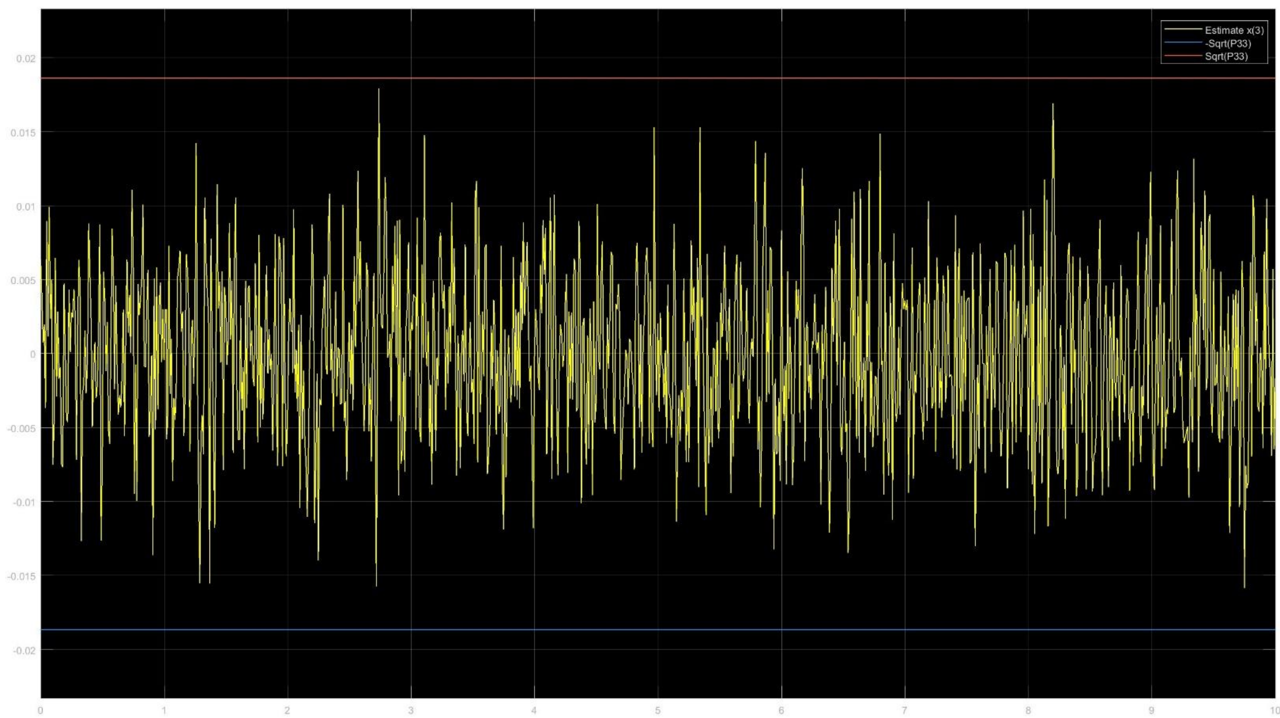
According to the response obtained from the DKF and the MLE, we can observe that the estimates are nearly similar in this case.

The following plot shows the estimates obtained from the DKF.

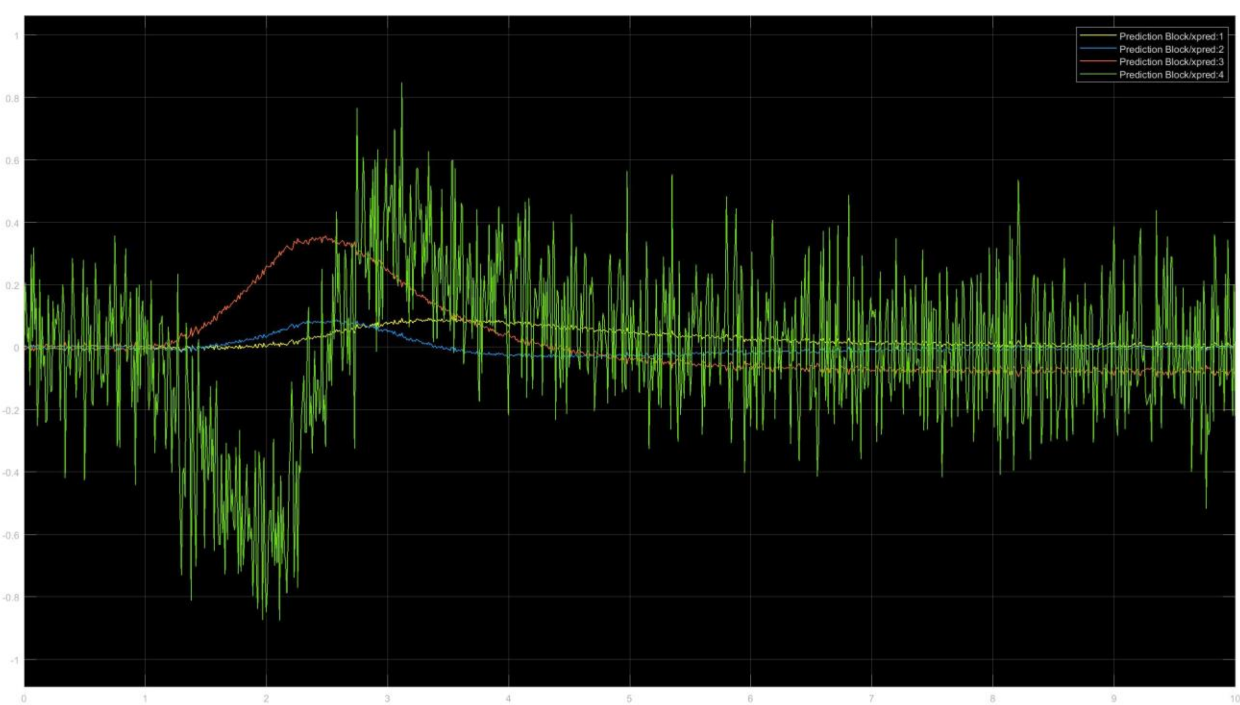
Estimates obtained from DKF.



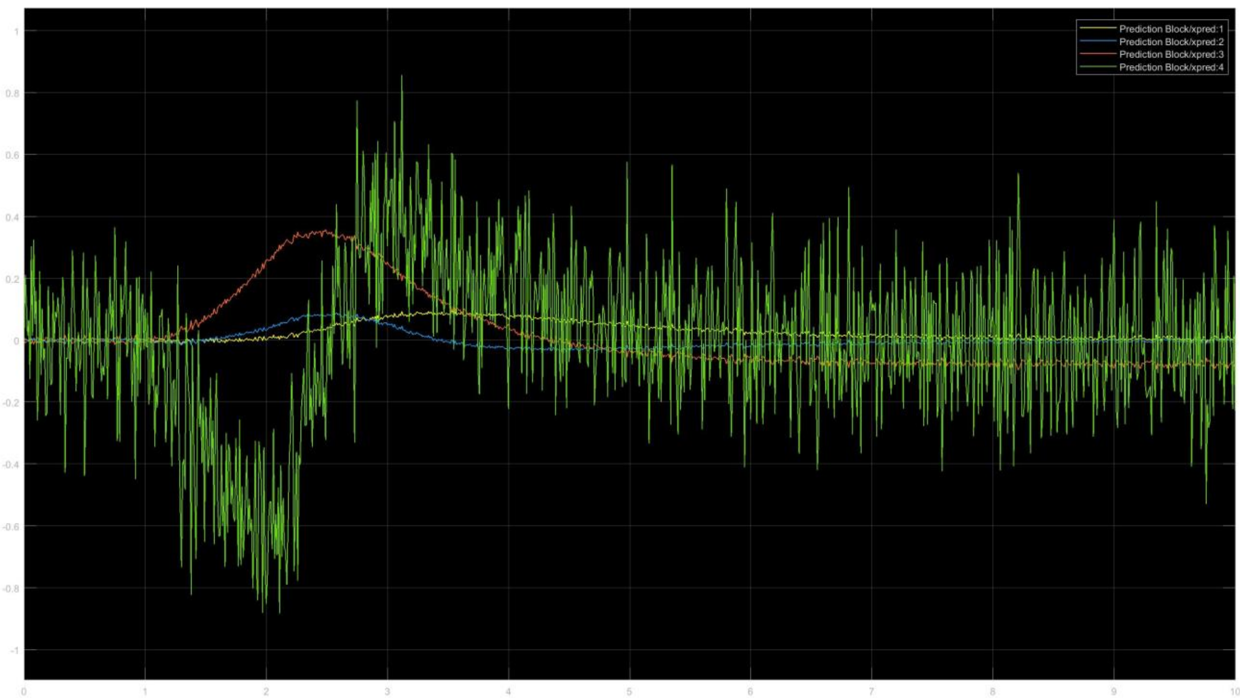
f) *Estimates obtained for state 4 within the square root value of the covariance matrix*



g) When Q=0.01*I, the response is as follows :-



When Q=100*I, the response is as follows :-


Prediction Block/xpred:1
Prediction Block/xpred:2
Prediction Block/xpred:3
Prediction Block/xpred:4
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
1
2
3
4
5
6
7
8
9
10