```
%clear
```

```
LF = RBS_out.Left_Flowrate
```

```
LF = 715×1
   12.1781
   11.9924
   11.9878
   11.9868
   11.9656
   12.0512
   11.9851
   10.3447
   13.1056
   13.5014
     ⋮
```

```
RF = RBS_out.Right_Flowrate
```

```
RF = 715×1
   11.8161
   12.1506
   12.1436
   12.1317
   11.8683
   12.1460
   12.1225
   10.5430
   10.4985
   13.1037
     ⋮
```

```
LLL = RBS_out.Lower_Left_Level
```

```
LLL = 715×1
    0.1897
    0.1910
    0.1906
    0.1906
    0.1905
    0.1906
    0.1909
    0.1897
    0.1895
    0.1889
     ⋮
```

```
TLL = RBS_out.Top_Left_Level
```

```
TLL = 715×1
    0.0309
    0.0308
    0.0313
    0.0317
    0.0319
    0.0322
    0.0324
```

```
    0.0279
    0.0271
    0.0279
     ⋮
```

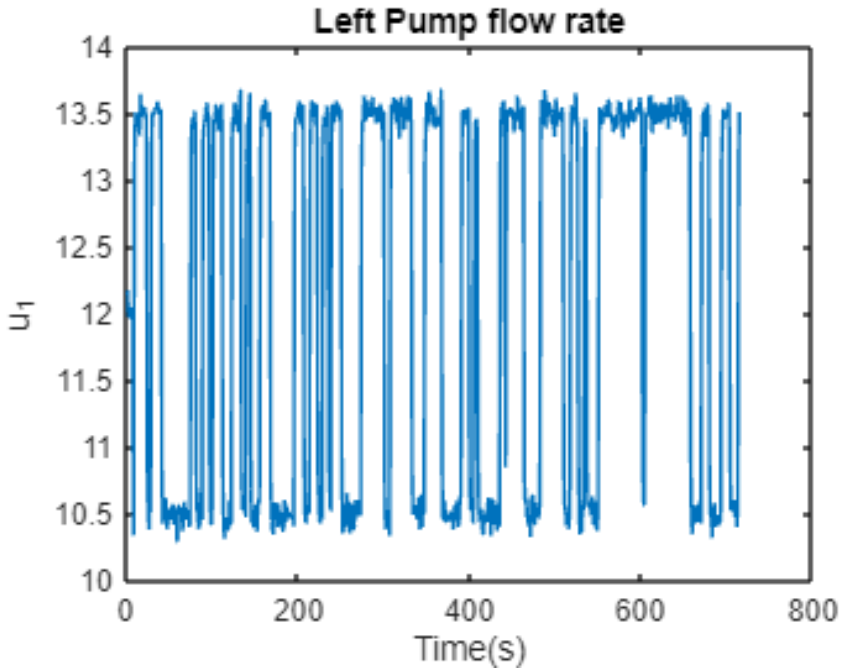
```
LRL = RBS_out.Lower_Right_Level
```

```
LRL = 715×1
    0.1034
    0.1045
    0.1049
    0.1041
    0.1042
    0.1039
    0.1029
    0.1058
    0.1071
    0.1107
     ⋮
```

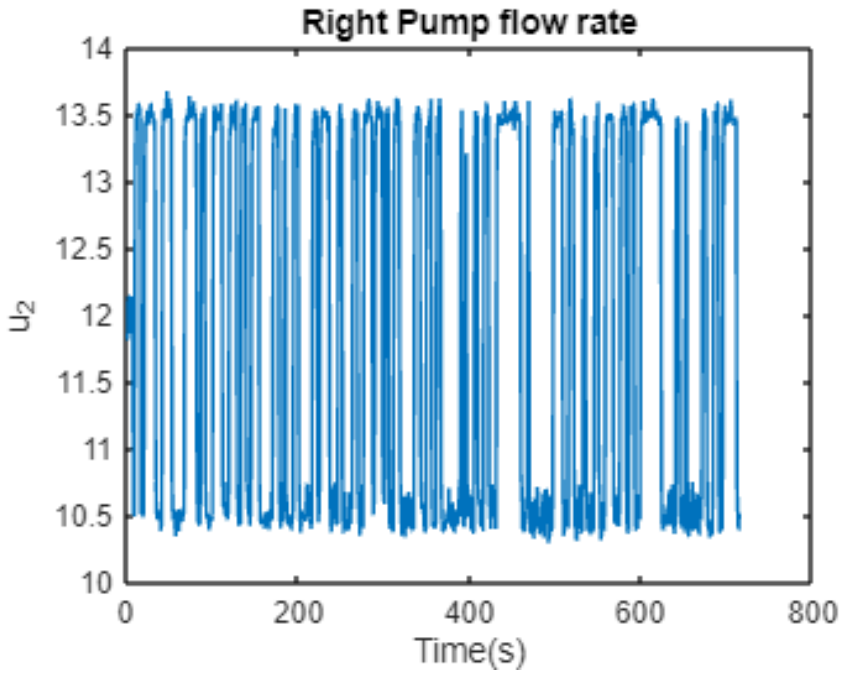
```
TRL = RBS_out.Top_Right_Level
```

```
TRL = 715×1
    0.0288
    0.0282
    0.0280
    0.0281
    0.0283
    0.0283
    0.0282
    0.0268
    0.0270
    0.0298
     ⋮
```

```
figure
plot(LF)
ylabel('u_1')
xlabel('Time(s)')
title('Left Pump flow rate')
```

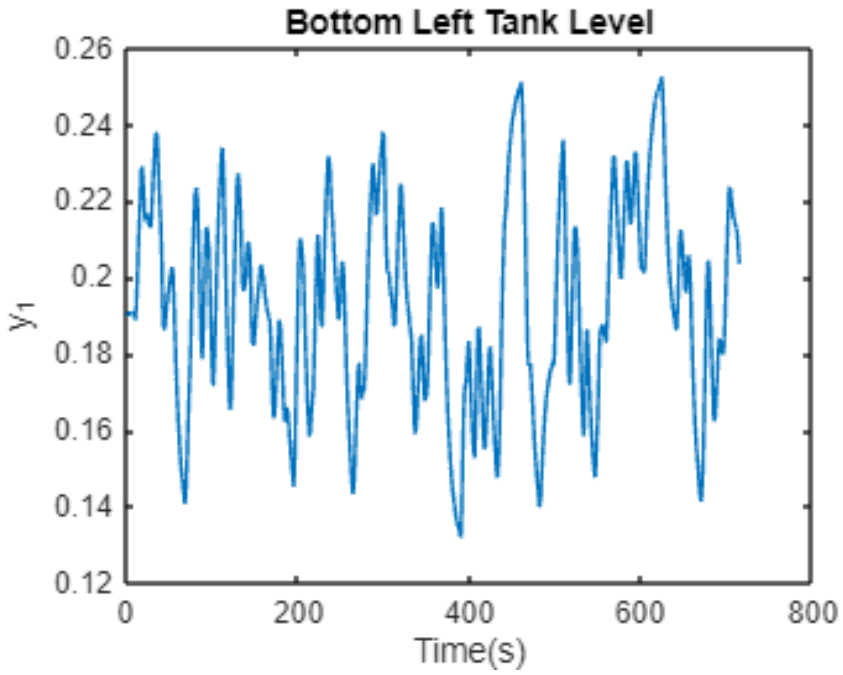



```
figure (2)
plot(RF)
ylabel('u_2')
xlabel('Time(s)')
title('Right Pump flow rate')
```

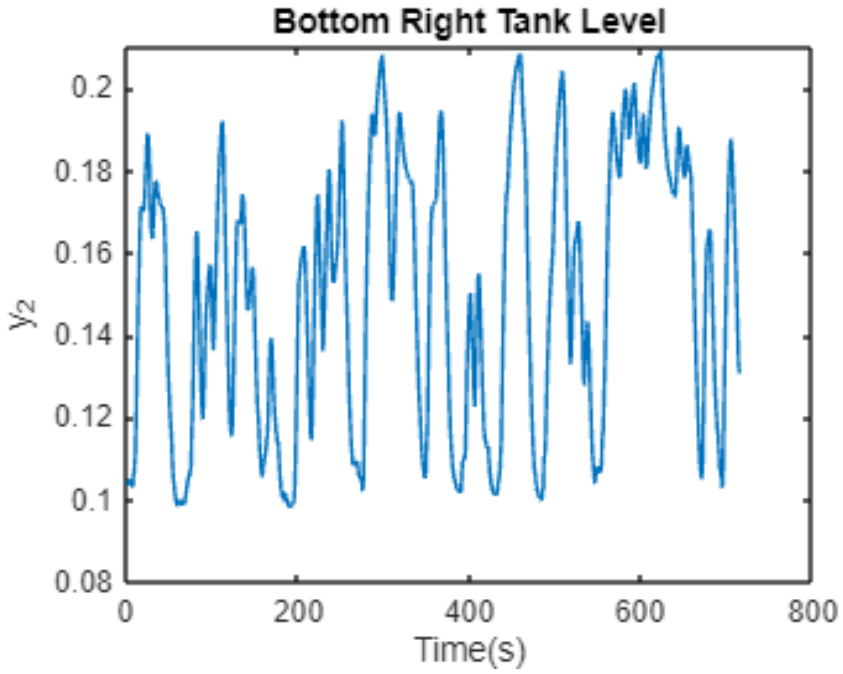



```
%%
figure (3)
plot(LLL)
ylabel('y_1')
xlabel('Time(s)')
```

```
title('Bottom Left Tank Level')
```

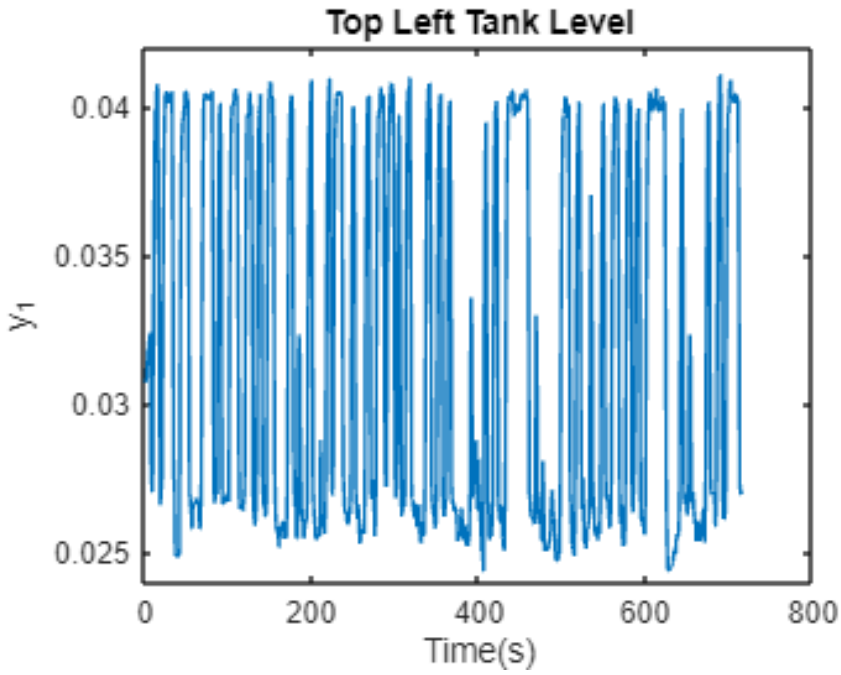



```
%%
figure (4)
plot(LRL)
ylabel('y_2')
xlabel('Time(s)')
title('Bottom Right Tank Level')
ylim([0.08 0.21])
```

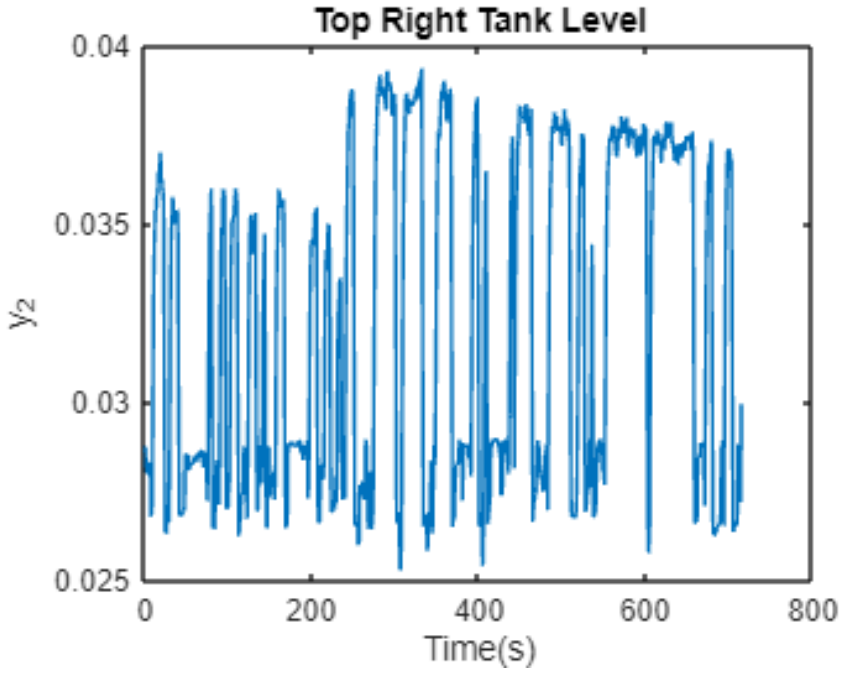



```
%%
figure (5)
```

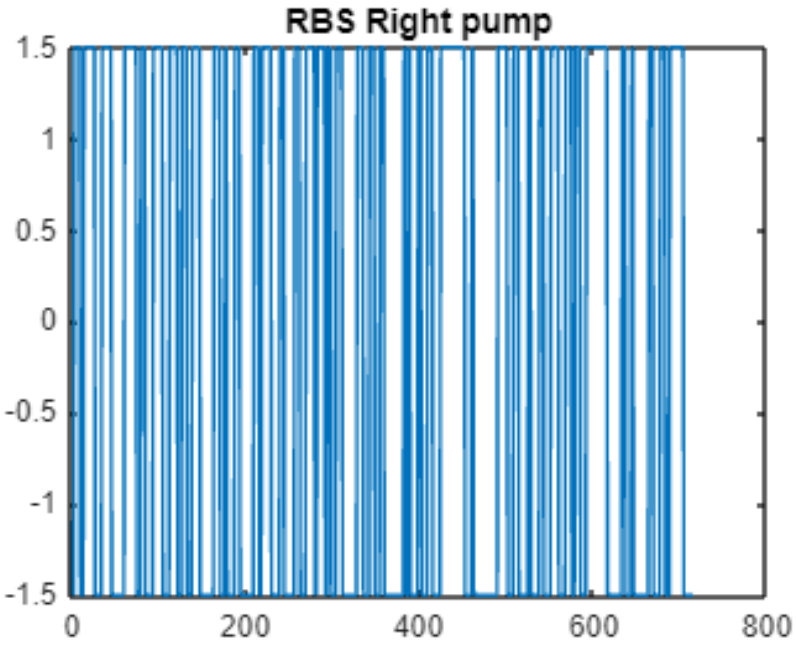
```
plot(TLL)
ylabel('y_1')
xlabel('Time(s)')
title('Top Left Tank Level')
```



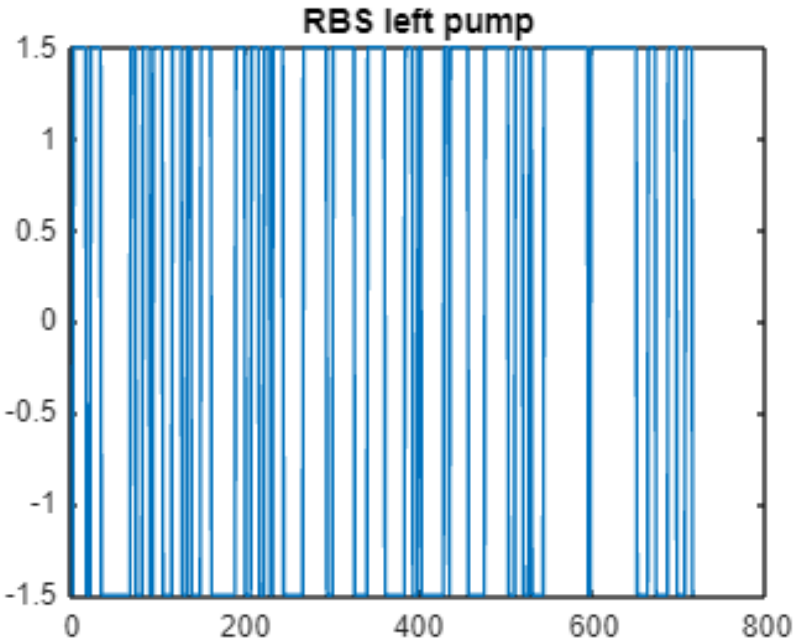

```
%%
figure (6)
plot(TRL)
ylabel('y_2')
xlabel('Time(s)')
title('Top Right Tank Level')
```



```
figure(7)
plot(RBS_R(:,2))
title('RBS Right pump')
```




```
figure(8)
plot(RBS_L(:,2))
title('RBS left pump')
```




```
y1 = LLL
```

```
y1 = 715×1
```

```
    0.1897
    0.1910
    0.1906
    0.1906
    0.1905
    0.1906
    0.1909
    0.1897
    0.1895
    0.1889
     ⋮
```

```
y2 = LRL
```

```
y2 = 715×1
    0.1034
    0.1045
    0.1049
    0.1041
    0.1042
    0.1039
    0.1029
    0.1058
    0.1071
    0.1107
     ⋮
```

```
u1 = LF
```

```
u1 = 715×1
   12.1781
   11.9924
   11.9878
   11.9868
   11.9656
   12.0512
   11.9851
   10.3447
   13.1056
   13.5014
     ⋮
```

```
u2 = RF
```

```
u2 = 715×1
   11.8161
   12.1506
   12.1436
   12.1317
   11.8683
   12.1460
   12.1225
   10.5430
   10.4985
   13.1037
     ⋮
```

```
%Ts = 14  Sample time used in RBS
```

```
z_L = iddata(y1,[u1 u2],Ts)
```

```
z_L =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1
   u2

Data Properties
```

```
z_R = iddata(y2,[u1 u2],Ts)
```

```
z_R =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1
   u2

Data Properties
```

```
nk1 = delayest(z_L,3,3,1,100)
```

```
nk1 = 1×2
     1     2
```

```
nk2 = delayest(z_R,3,3,1,100)
```

```
nk2 = 1×2
     1     2
```

```
% ARX approxiamtion for outlier detection
ARX1 = arx(z_L,[3 [3 3], nk1])
```

```
ARX1 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.522 z^-1 + 0.395 z^-2 + 0.1639 z^-3

  B1(z) = 0.001342 z^-1 - 0.0009701 z^-2 - 0.000249 z^-3

  B2(z) = 0.001624 z^-2 - 0.0005987 z^-3 - 0.0005559 z^-4

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   na=3   nb=[3 3]   nk=[1 2]
   Number of free coefficients: 9
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.
```

```
Status:
Estimated using ARX on time domain data "z_L".
Fit to estimation data: 93.39% (prediction focus)
FPE: 3.201e-06, MSE: 3.096e-06

Model Properties
```

```
ARX2 = arx(z_R,[3 [3 3] nk2])
```

```
ARX2 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.906 z^-1 + 1.072 z^-2 - 0.1413 z^-3

  B1(z) = 0.001148 z^-1 + 0.0003579 z^-2 - 0.0008868 z^-3

  B2(z) = -0.0001553 z^-2 - 3.341e-05 z^-3 - 0.0001356 z^-4

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   na=3   nb=[3 3]   nk=[1 2]
   Number of free coefficients: 9
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "z_R".
Fit to estimation data: 94.22% (prediction focus)
FPE: 3.747e-06, MSE: 3.624e-06

Model Properties
```

```
% Defining residual
R1 = predict(ARX1,z_L,1)
```

```
R1 =

Time domain data set with 715 samples.
Sample time: 14 seconds
Name: z_L_Predicted

Outputs      Unit (if specified)
   y1

Data Properties
```

```
es_1 = (y1 - R1.y)
```

```
es_1 = 715×1
         0
   -0.0000
         0
   -0.0072
   -0.0004
    0.0000
    0.0004
   -0.0018
    0.0024
   -0.0010
      ⋮
      ⋮
```

```
R2 = predict(ARX2,z_R,1)
```

```
R2 =

Time domain data set with 715 samples.
Sample time: 14 seconds
Name: z_R_Predicted

Outputs      Unit (if specified)
   y1

Data Properties
```

```
es_2 = (y2 - R2.y)
```

```
es_2 = 715×1
         0
   -0.0000
         0
   -0.0034
   -0.0001
   -0.0013
   -0.0019
    0.0028
   -0.0005
    0.0010
     ⋮
```

```
N_1 = length(y1); % No. of data
P = 9; % No. of parameters
MSE_1 = es_1'*es_1/(N_1-P)
```

```
MSE_1 = 3.1352e-06
```

```
MSE_2 = es_2'*es_2/(N_1-P)
```

```
MSE_2 = 3.6698e-06
```

```
d1 = es_1./sqrt(MSE_1)
```

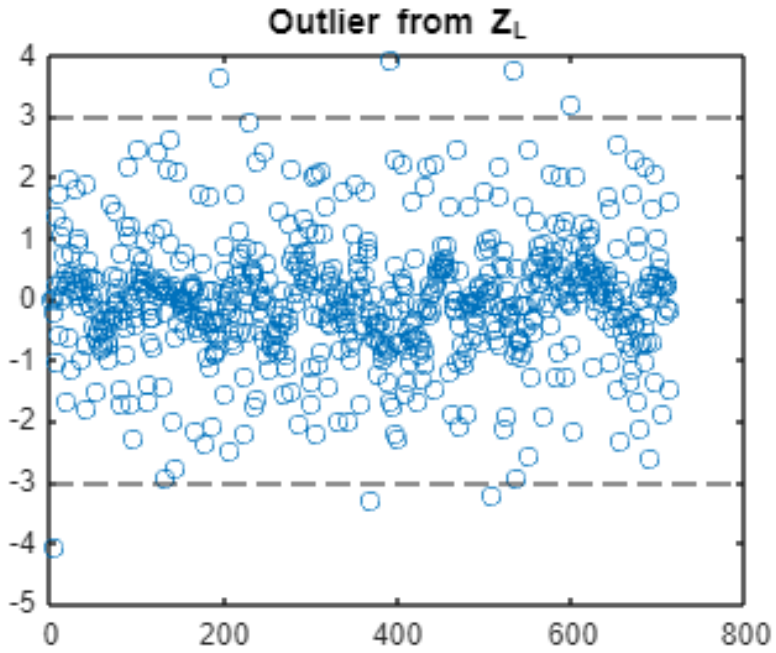
```
d1 = 715×1
         0
   -0.0000
         0
   -4.0567
   -0.2079
    0.0113
    0.2407
   -1.0167
    1.3497
   -0.5887
     ⋮
```

```
d2 = es_2./sqrt(MSE_2)
```

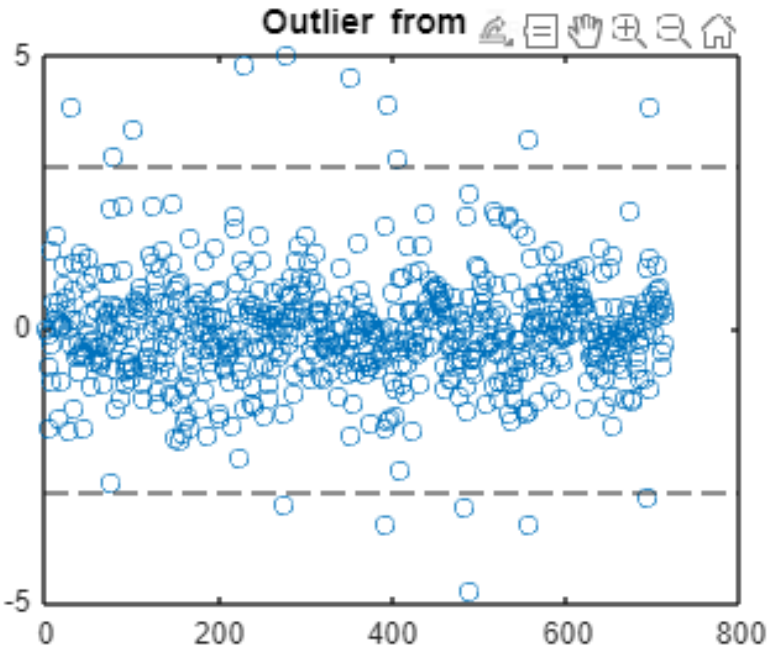
```
d2 = 715×1
         0
   -0.0000
         0
```

```
   -1.7878
   -0.0727
   -0.6933
   -0.9666
    1.4608
   -0.2863
    0.4971
     ⋮
```

```
figure
plot(d1,'o')
yline(3,'--')
yline(-3,'--')
title('Outlier from Z_L')
```




```
figure(2)
plot(d2,'o')
yline(3,'--')
yline(-3,'--')
title('Outlier from Z_R')
```




```
% chnage the outlier with the predicted value
```

```
outliers_y1 = [];
outliers_y2 = [];

for i = 1:length(y1)
    if d1(i) > 3 || d1(i) < -3
        outliers_y1 = [outliers_y1; i, y1(i)];
    end
    if d2(i) > 3 || d2(i) < -3
        outliers_y2 = [outliers_y2; i, y2(i)];
    end
end

disp('Outliers in y1:')
```

```
Outliers in y1:
```

```
disp(outliers_y1) %7
```

```
    4.0000    0.1906
  196.0000    0.1509
  368.0000    0.2172
  391.0000    0.1394
  510.0000    0.2322
  534.0000    0.1617
  601.0000    0.2027
```

```
disp('Outliers in y2:')
```

```
Outliers in y2:
```

```
disp(outliers_y2) %16
```

```
   29.0000    0.1644
   78.0000    0.1344
  102.0000    0.1404
  230.0000    0.1415
  275.0000    0.1025
  277.0000    0.1146
  352.0000    0.1336
  393.0000    0.1095
  396.0000    0.1198
  407.0000    0.1290
  484.0000    0.0997
  488.0000    0.1106
  556.0000    0.1166
  557.0000    0.1258
  695.0000    0.1030
  697.0000    0.1232
```

```
z_L = iddata(y1,[u1 u2],Ts)
```

```
z_L =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1
   u2

Data Properties
```

```
z_R = iddata(y2,[u1 u2],Ts)
```

```
z_R =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1
   u2

Data Properties
```

```
delayest(z_L)
```

```
ans = 1×2
     0     1
```

```
delayest(z_R)
```

```
ans = 1×2
     1     1
```

```
ZT_1 = z_L(1:ceil(0.7*length(y1))); % Extract identification data 1st output
ZT_2 = z_R(1:ceil(0.7*length(y2))); % Extract identification data 2nd output
ZV_1 = z_L(ceil(0.7*length(y1))+1:end); % Valid identification data 1st
output
ZV_2 = z_R(ceil(0.7*length(y2))+1:end); % Valid identification data 1st
output
```

```
ZT_1 = dtrend(ZT_1); % Final testing data for y1
ZT_2 = dtrend(ZT_2); % Final testing data for y2
ZV_1 = dtrend(ZV_1); % Final validation data for y1
ZV_2 = dtrend(ZV_2); % Final validation data for y2
```

```
nk1_Tf = delayest(ZT_1,3,3,1,100)
```

```
nk1_Tf = 1×2
     1     2
```

```
nk2_Tf = delayest(ZT_2,3,3,1,100)
```

```
nk2_Tf = 1×2
     1     1
```

```
z_11 = iddata (y1, u1, Ts)
```

```
z_11 =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1

Data Properties
```

```
z_12 = iddata (y1, u2, Ts)
```

```
z_12 =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1

Data Properties
```

```
z_13 = iddata (y2, u1, Ts)
```

```
z_13 =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1

Data Properties
```

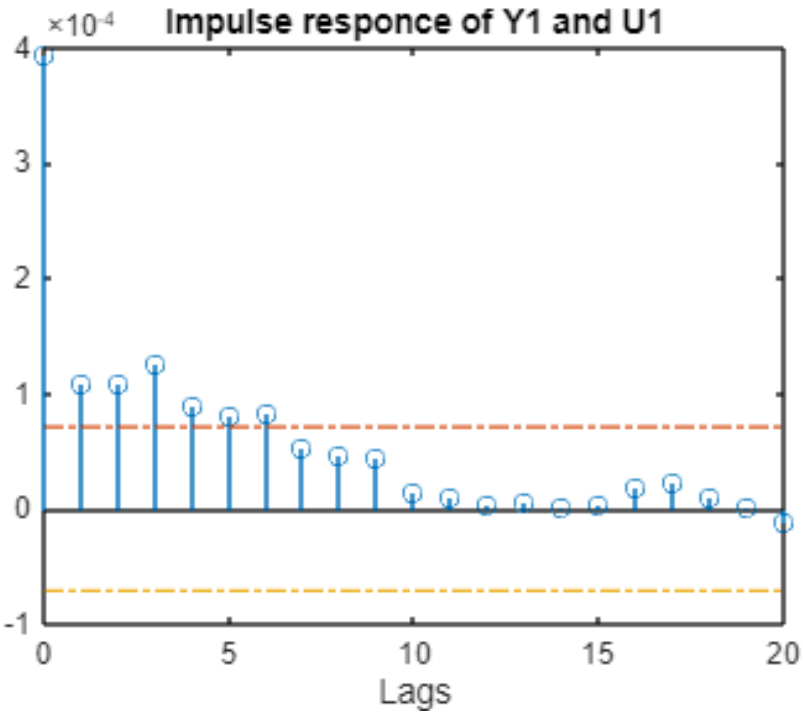
```
z_14 = iddata (y2, u2, Ts)
```

```
z_14 =

Time domain data set with 715 samples.
Sample time: 14 seconds

Outputs      Unit (if specified)
   y1

Inputs       Unit (if specified)
   u1

Data Properties
```

```
figure
cra (z_11)
```

```
ans = 21×1
    0.0055
    0.0015
    0.0015
    0.0017
    0.0013
    0.0011
    0.0012
    0.0007
    0.0007
    0.0006
     ⋮
     ⋮
```

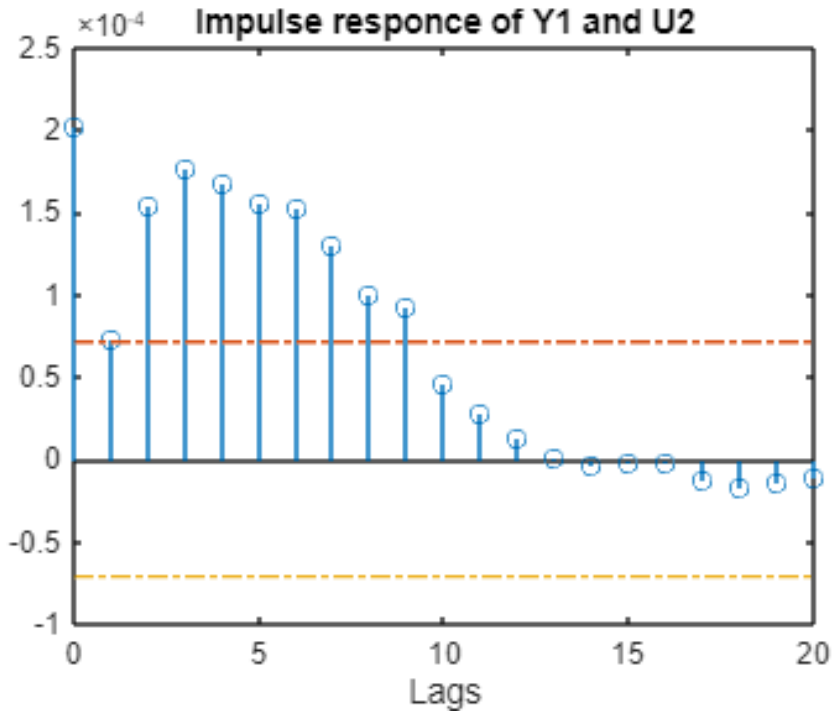
```
title('Impulse responce of Y1 and U1')
```




```
figure
cra (z_12)
```

```
ans = 21×1
    0.0028
    0.0010
    0.0022
    0.0025
    0.0023
    0.0022
    0.0021
    0.0018
    0.0014
    0.0013
     ⋮
```

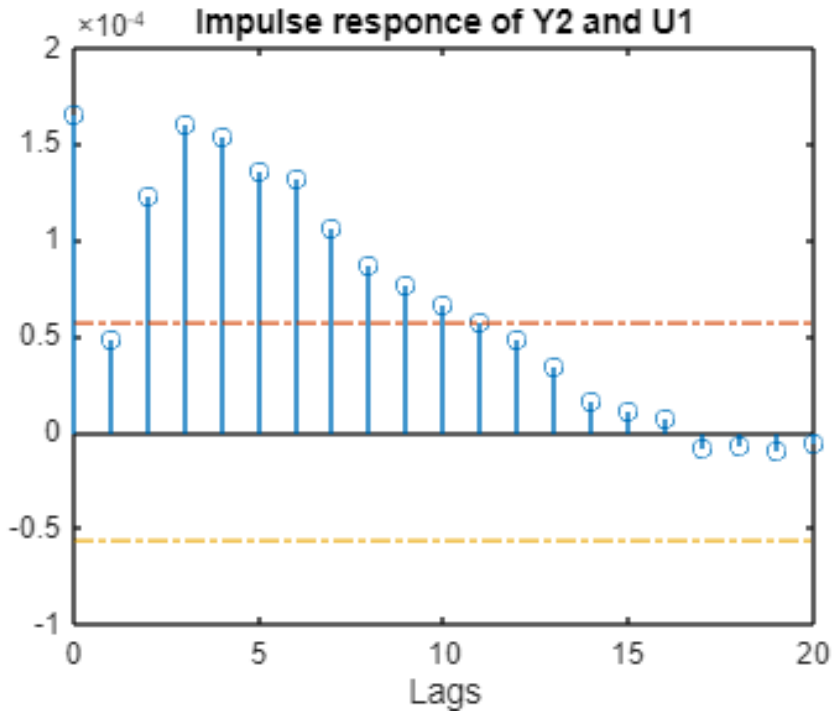
```
title('Impulse responce of Y1 and U2')
```




```
figure
cra (z_13)
```

```
ans = 21×1
    0.0023
    0.0007
    0.0017
    0.0022
    0.0021
    0.0019
    0.0019
    0.0015
    0.0012
    0.0011
     ⋮
```

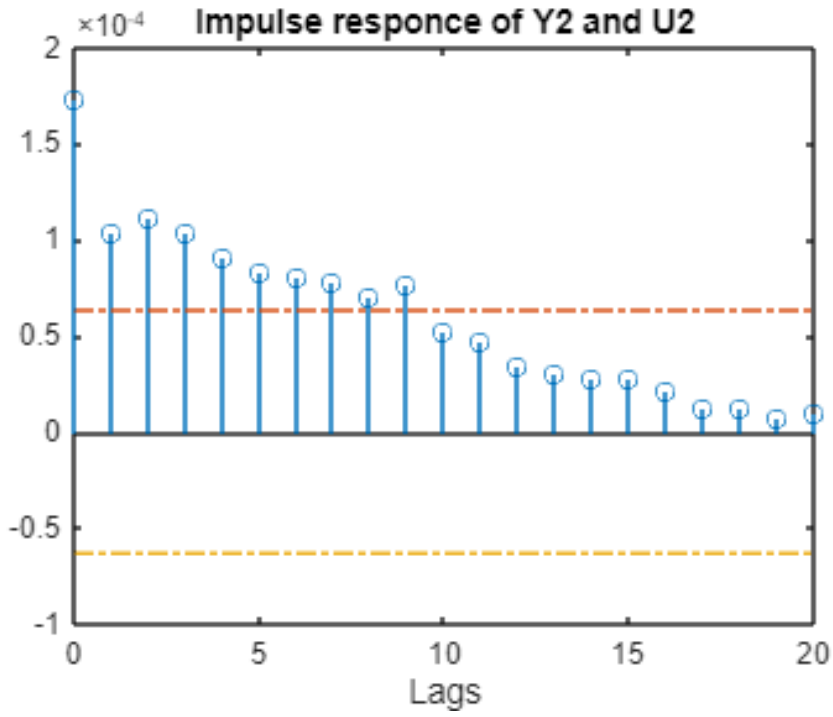
```
title('Impulse responce of Y2 and U1')
```




```
figure
cra (z_14)
```

```
ans = 21×1
    0.0024
    0.0015
    0.0016
    0.0015
    0.0013
    0.0012
    0.0011
    0.0011
    0.0010
    0.0011
     ⋮
```

```
title('Impulse responce of Y2 and U2')
```




```
clc
bode_11 = spa (z_L)
```

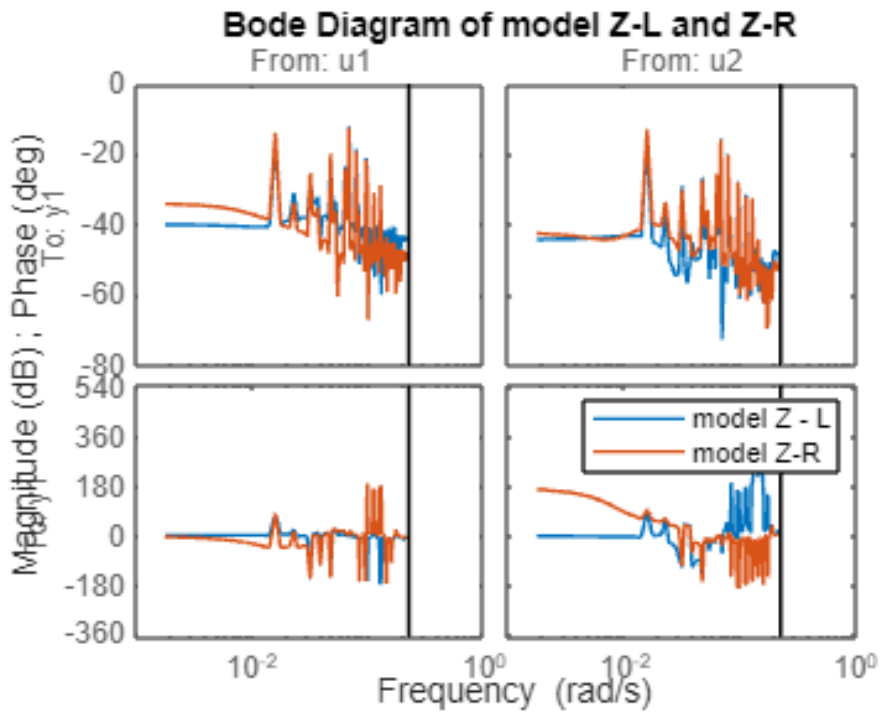
```
bode_11 =
IDFRD model.
Contains Frequency Response Data for 1 output(s) and 2 input(s), and the spectra for disturbances at the o
Response data and disturbance spectra are available at 128 frequency points, ranging from 0.001753 rad/s t

Sample time: 14 seconds
Output channels: 'y1'
Input channels: 'u1', 'u2'
Status:
Estimated using SPA on time domain data "z_L".

Model Properties
```

```
bode_12 = spa (z_R)
```

```
bode_12 =
IDFRD model.
Contains Frequency Response Data for 1 output(s) and 2 input(s), and the spectra for disturbances at the o
Response data and disturbance spectra are available at 128 frequency points, ranging from 0.001753 rad/s t

Sample time: 14 seconds
Output channels: 'y1'
Input channels: 'u1', 'u2'
Status:
Estimated using SPA on time domain data "z_R".

Model Properties
```

```
bode(bode_11,bode_12)
title ('Bode Diagram of model Z-L and Z-R ')
```

```
legend('model Z - L','model Z-R')
```




```
nk1_Tf = delayest(ZT_1,3,3,1,100)
```

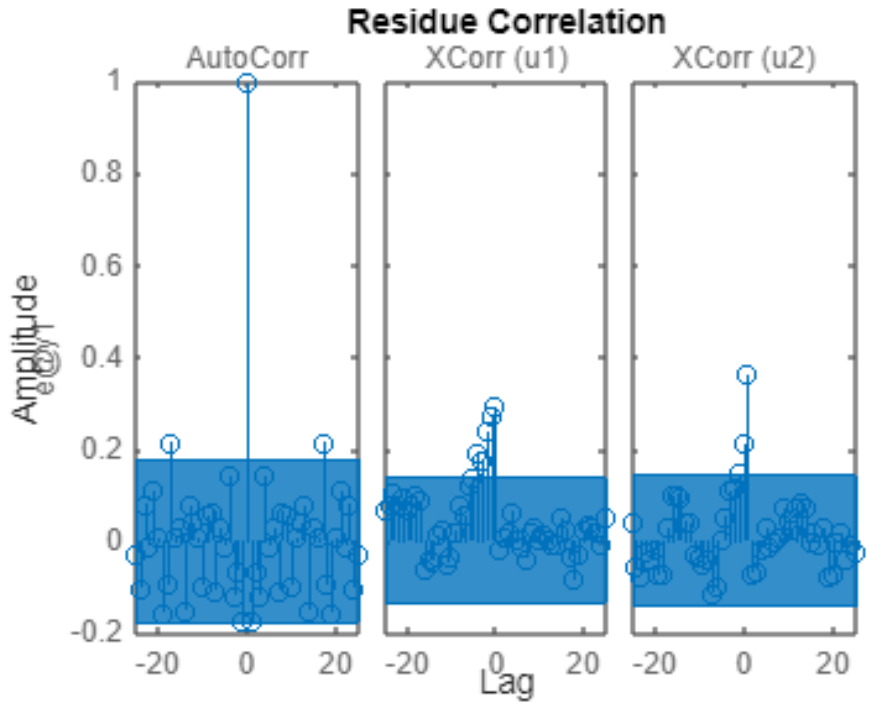
```
nk1_Tf = 1×2
     1     2
```

```
nk2_Tf = delayest(ZT_2,3,3,1,100)
```

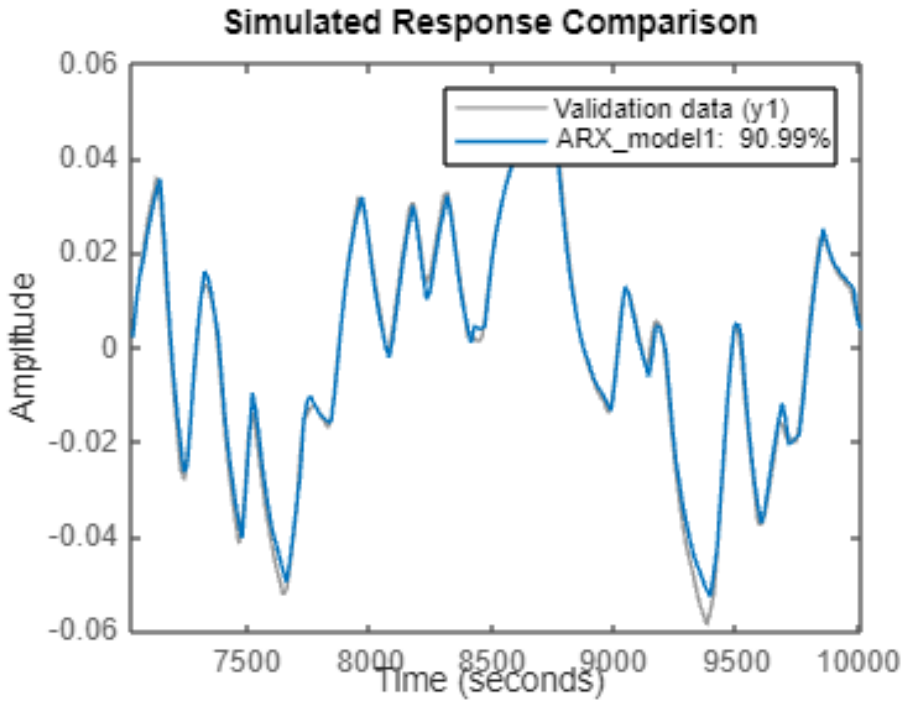
```
nk2_Tf = 1×2
     1     1
```

```
% z_f = iddata ([y1 y2], [u1 u2], Ts)
```

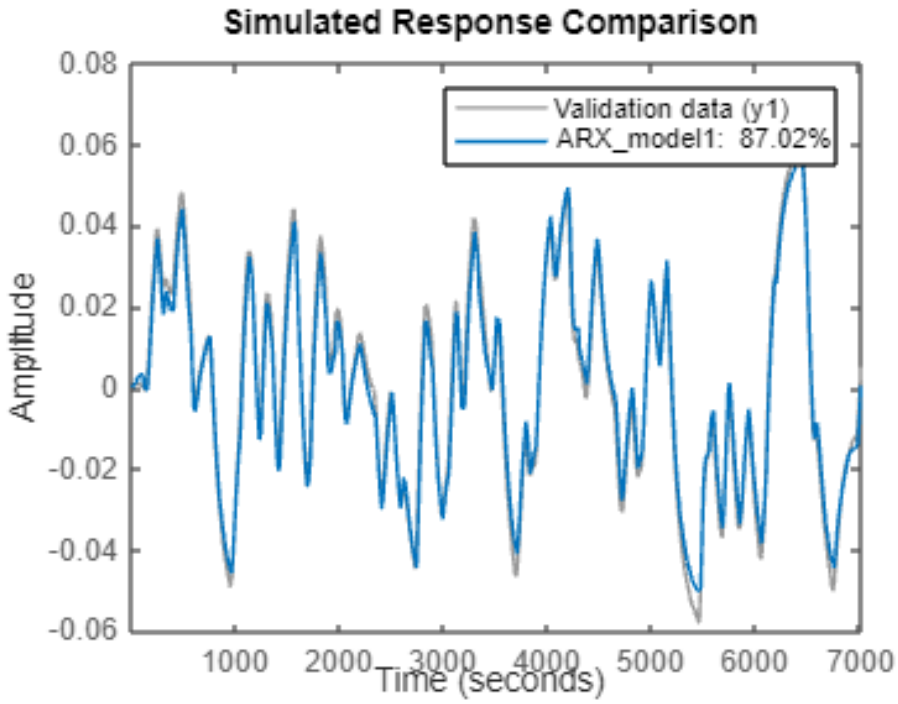
```
%% Model Identification
%%% ARX %%%

ARX_model1= arx(ZT_1,[1 [4 3] nk1_Tf]);
resid(ZV_1,ARX_model1)
```



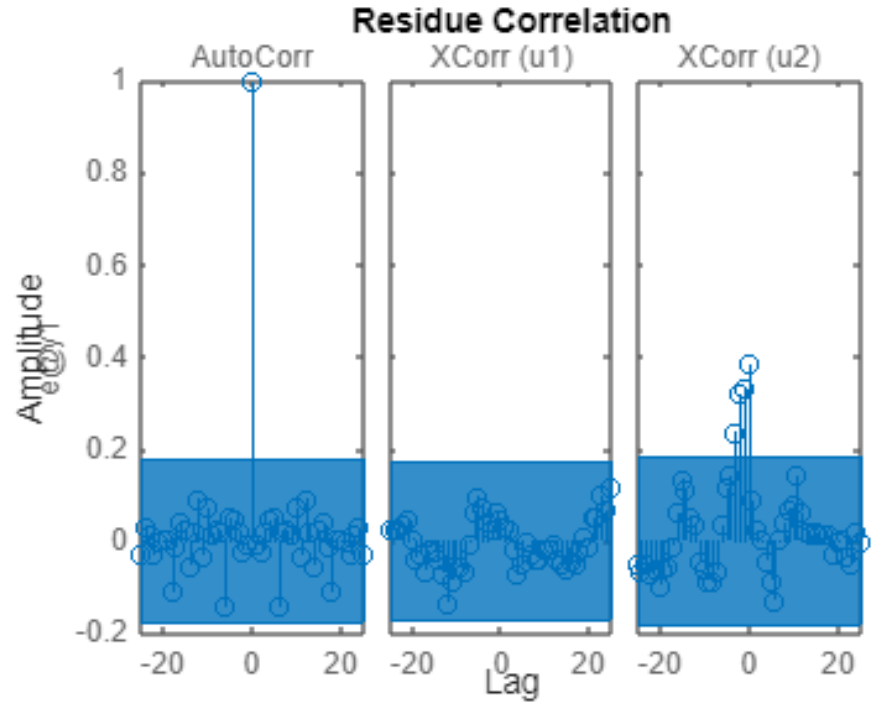

```
compare(ZV_1,ARX_model1)
```



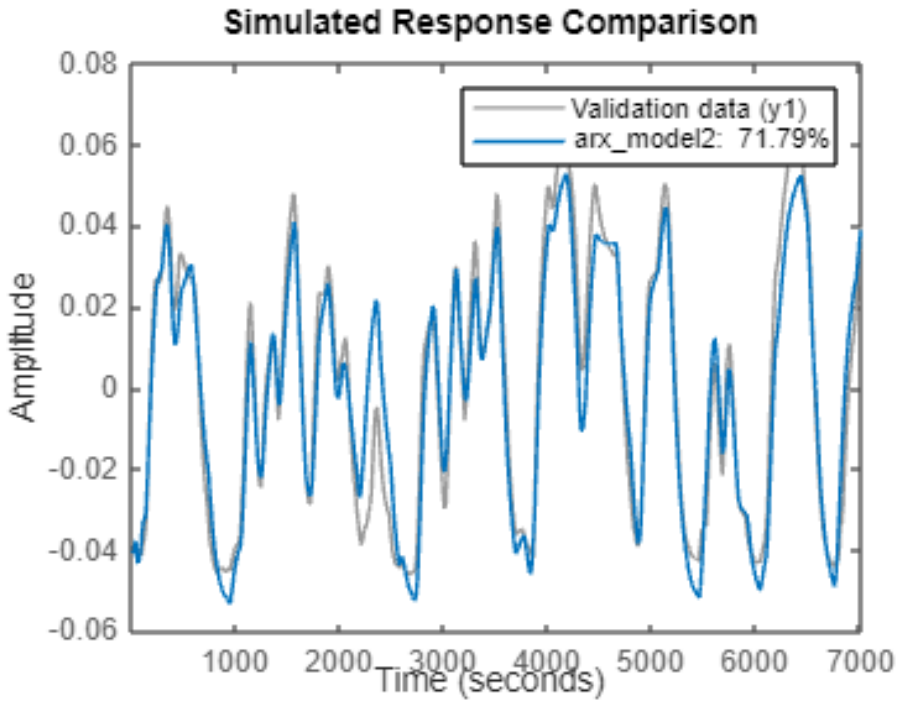

```
compare(ZT_1, ARX_model1)
```




```
arx_model2 = arx(ZT_2,[2 [3 4] nk2_Tf]); % 2 3 6
resid(ZV_2,arx_model2)
```



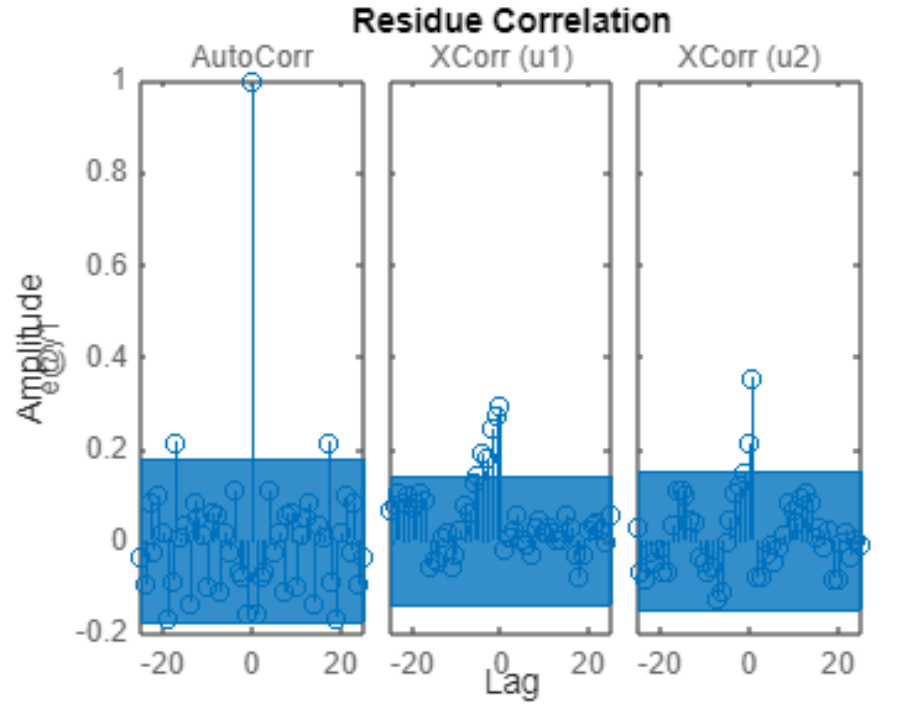

```
compare (ZT_2, arx_model2)
```



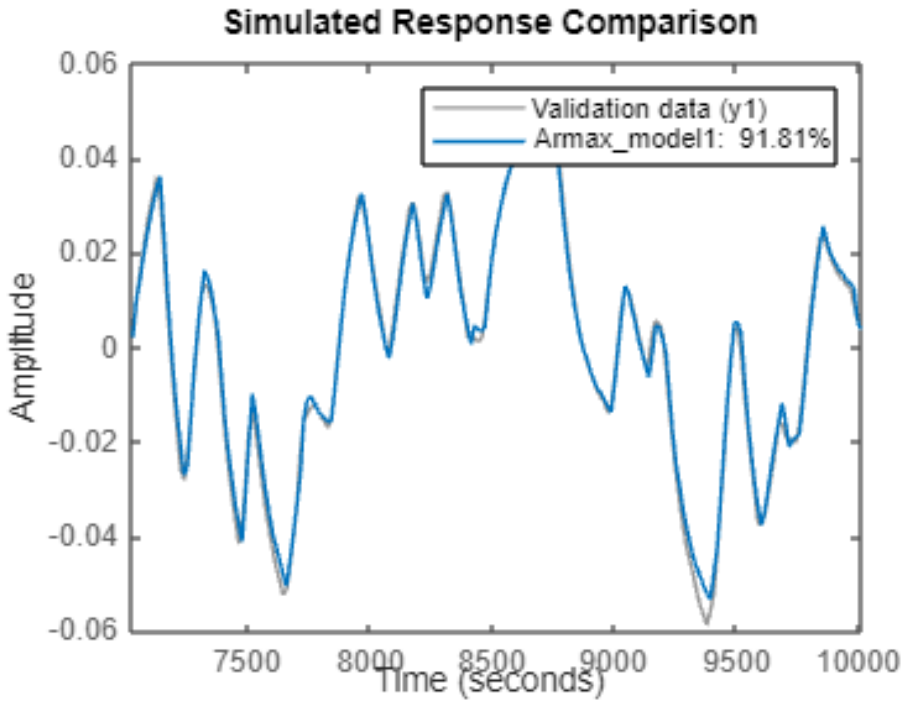

```
```

%%% ARMAX %%%

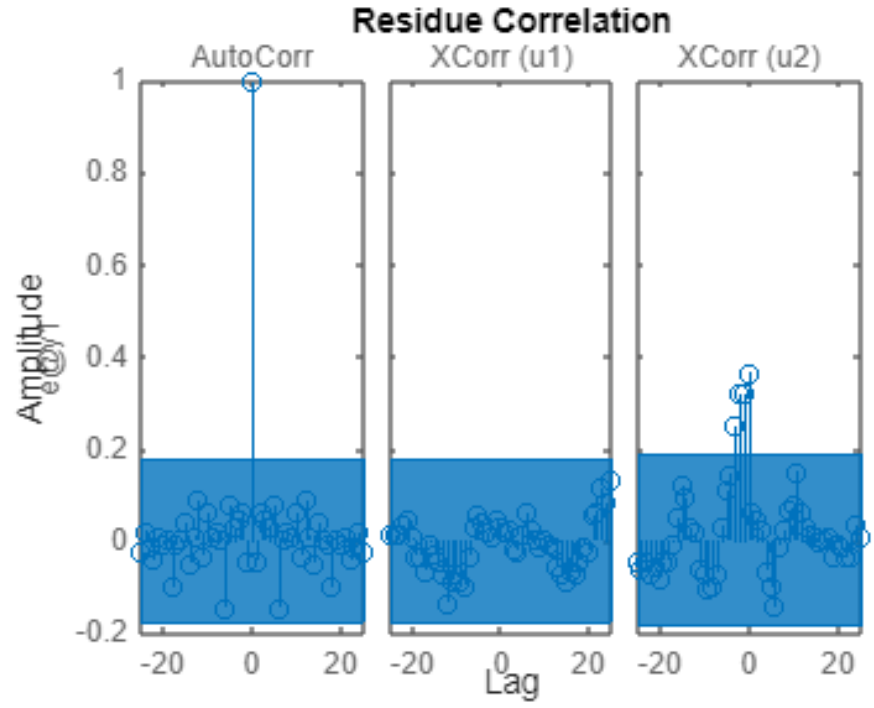
```
Armax_model1 = armax(ZT_1,[2 [3 3] 1 nk1_Tf]); %2 [2 2] 2
resid(ZV_1,Armax_model1)
```



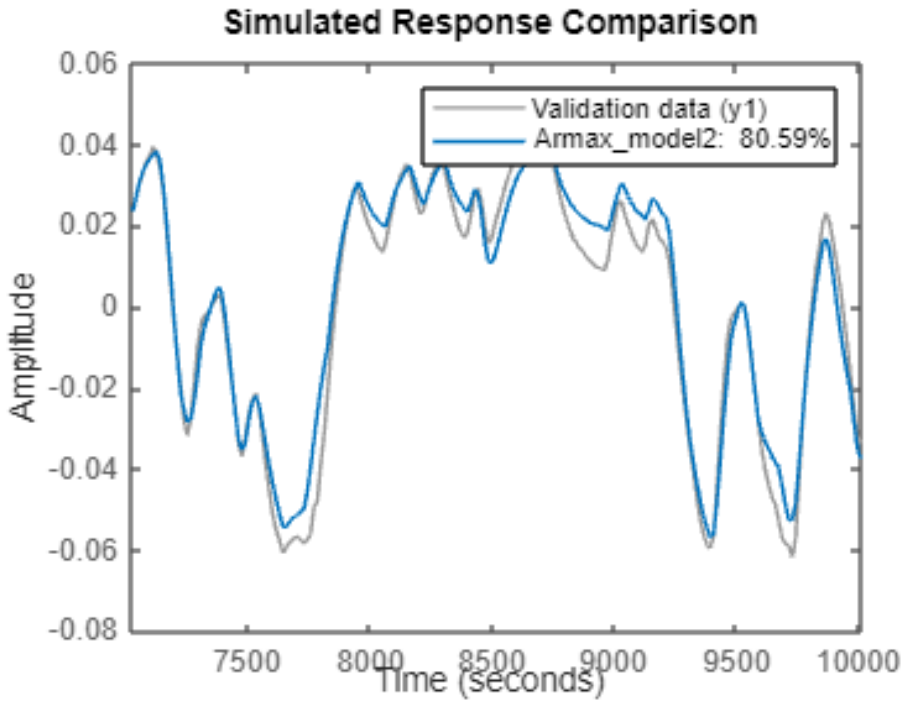

```
compare(ZV_1,Armax_model1)
```




```
Armax_model2 = armax(ZT_2,[2 [3 3] 1 nk2_Tf]); % 2 [3 3] 2
resid(ZV_2,Armax_model2)
```

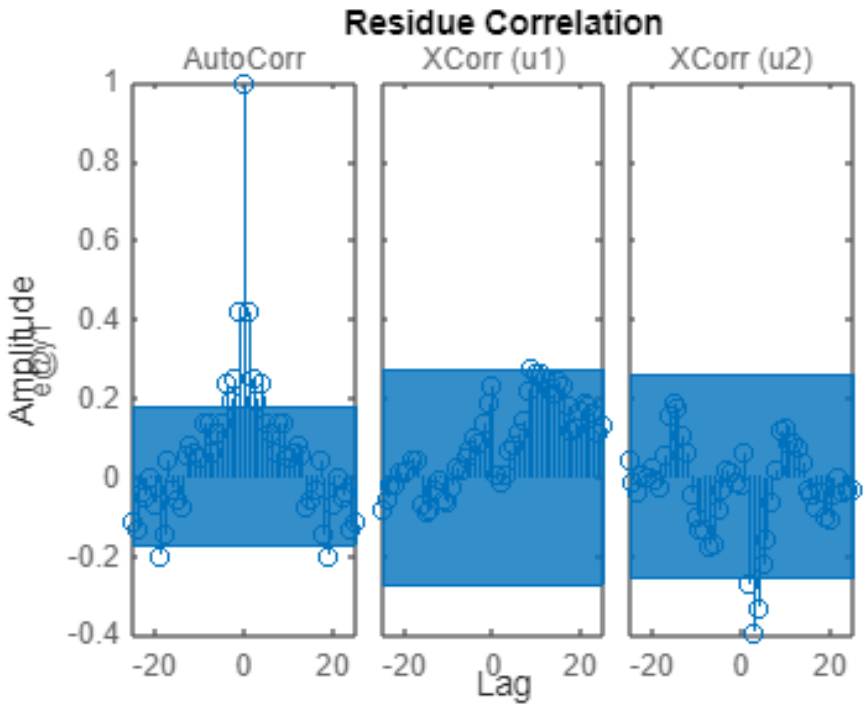



```
compare(ZV_2,Armax_model2)
```

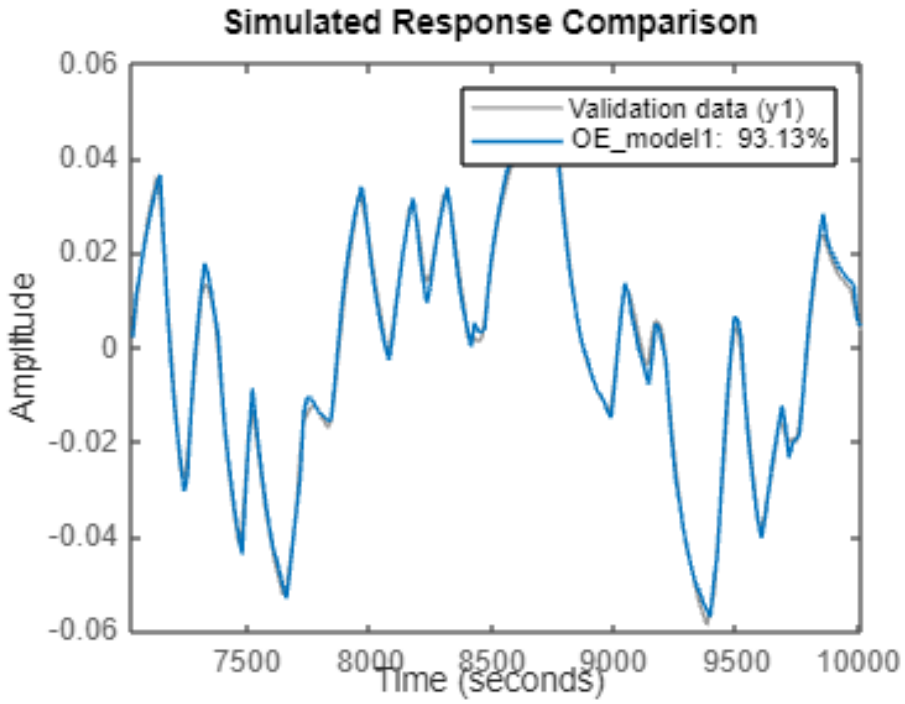


%%% OE %%%

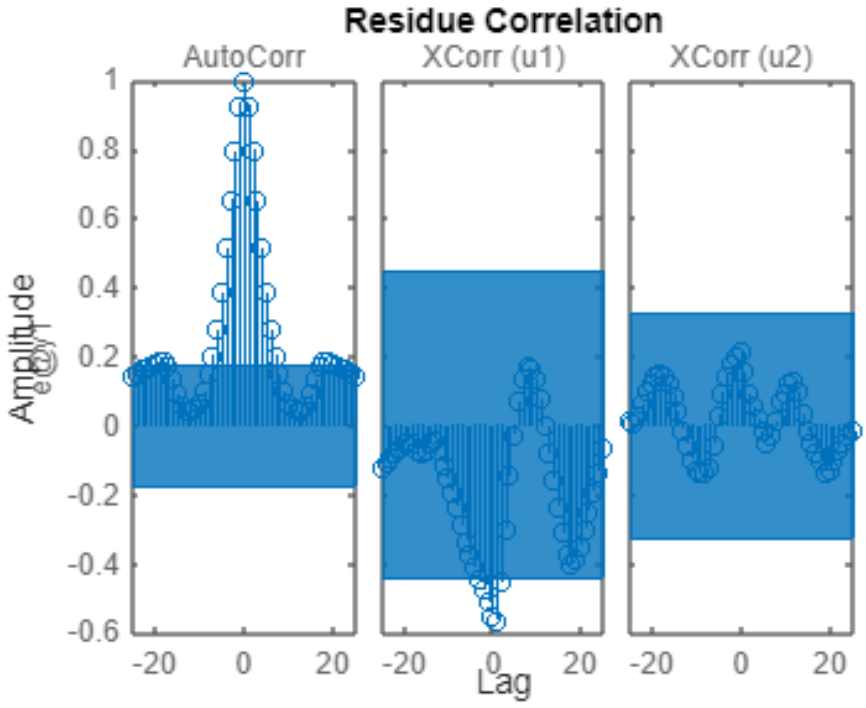
```
OE_model1 = oe(ZT_1,[[2 2] [1 1] nk1_Tf]);
resid(ZV_1,OE_model1)
```



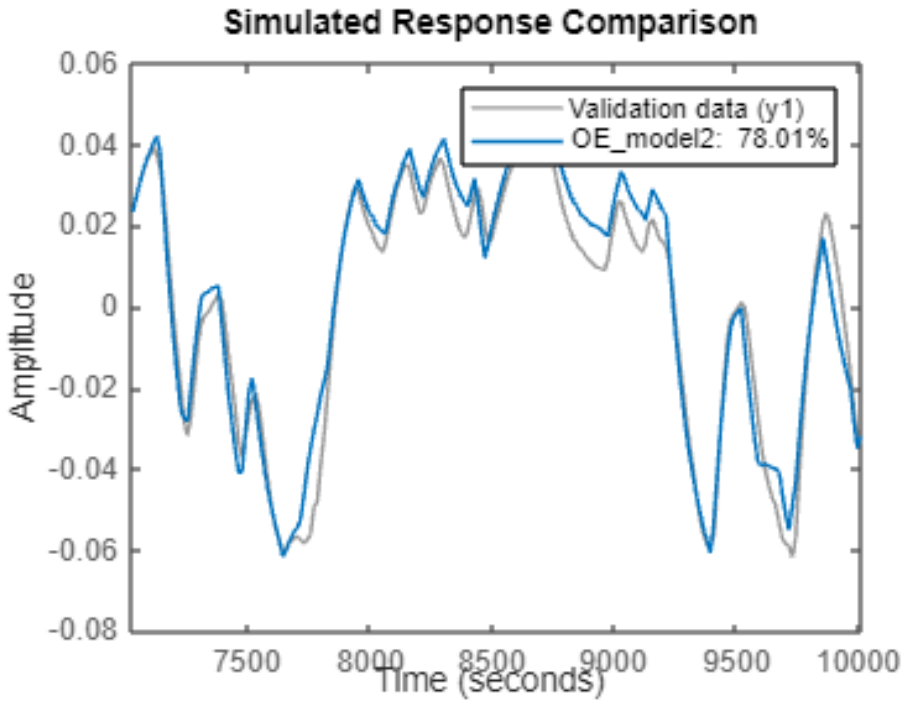

```
compare(ZV_1,OE_model1)
```




```
OE_model2 = oe(ZT_2,[[1 1] [1 1] nk2_Tf]);
resid(ZV_2,OE_model2)
```

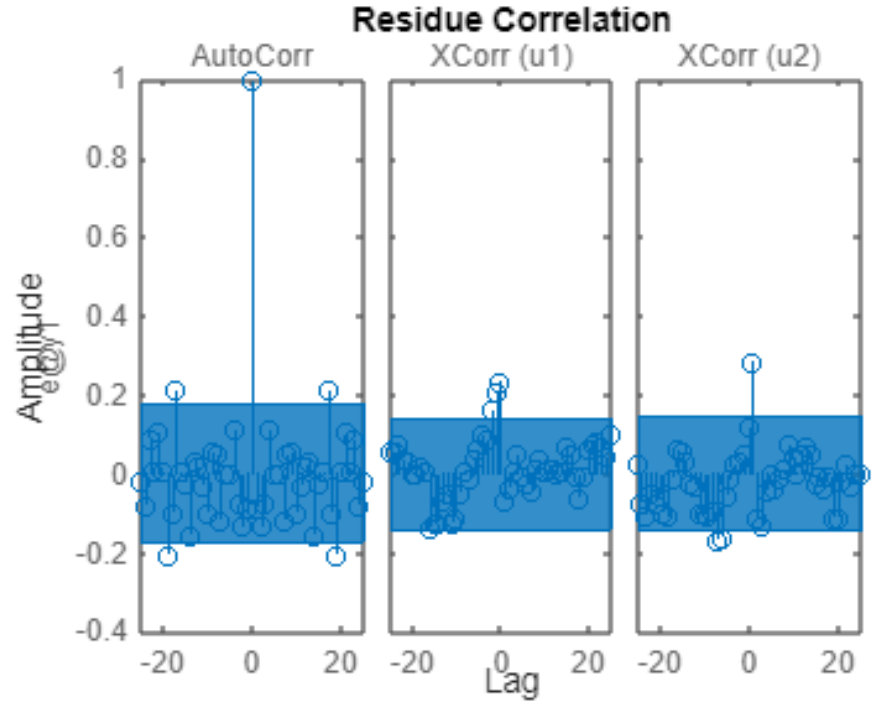



```
compare(ZV_2,OE_model2)
```

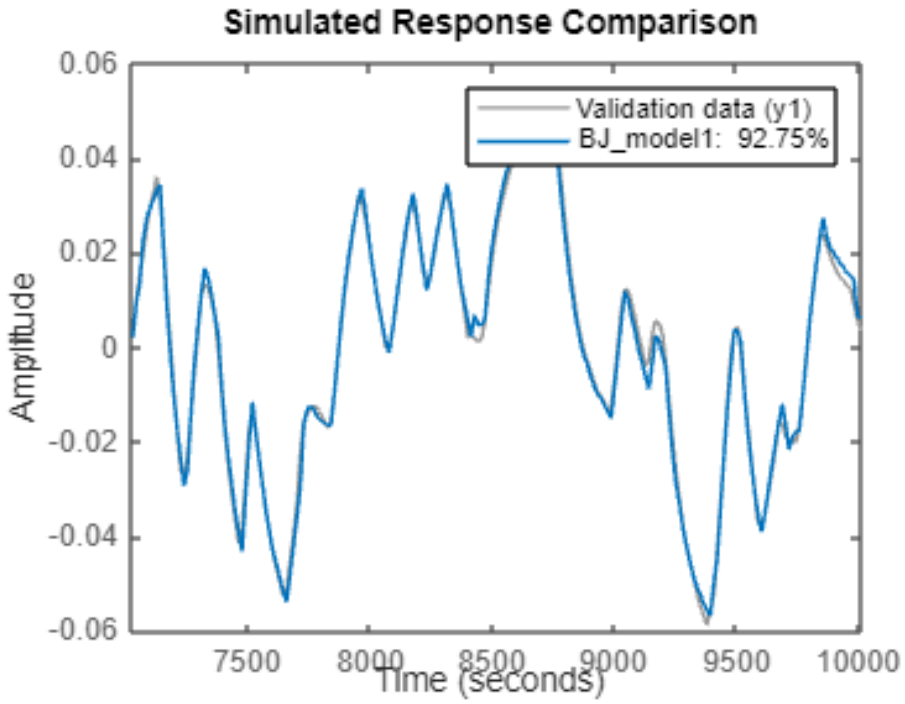


%%% BJ %%%

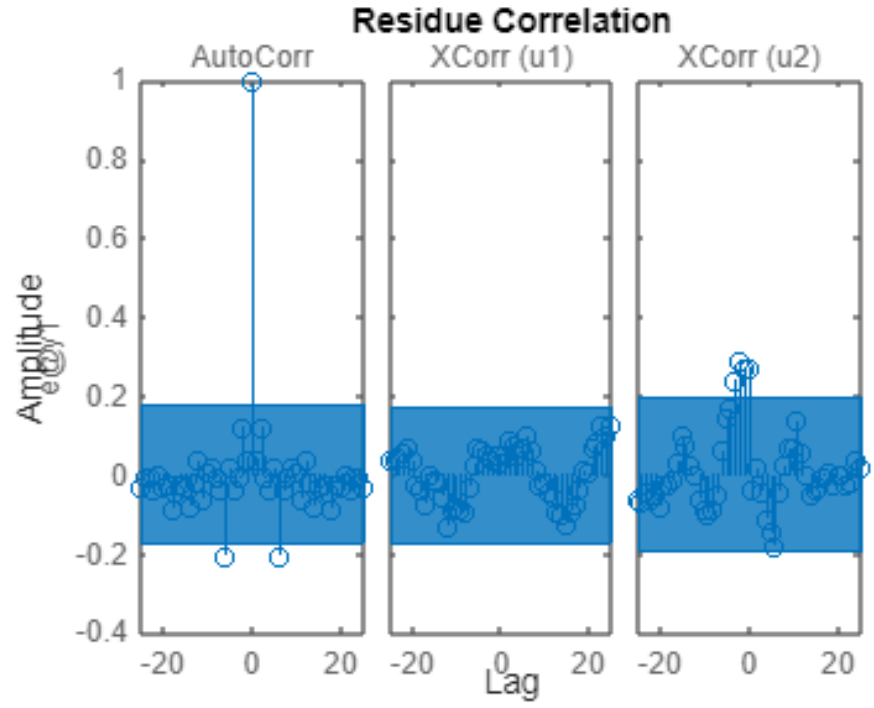
```
BJ_model1 = bj(ZT_1,[[4 2] 2 2 [2 2] nk1_Tf]); %[4 2] 2 2 [4 2]
resid(ZV_1,BJ_model1)
```



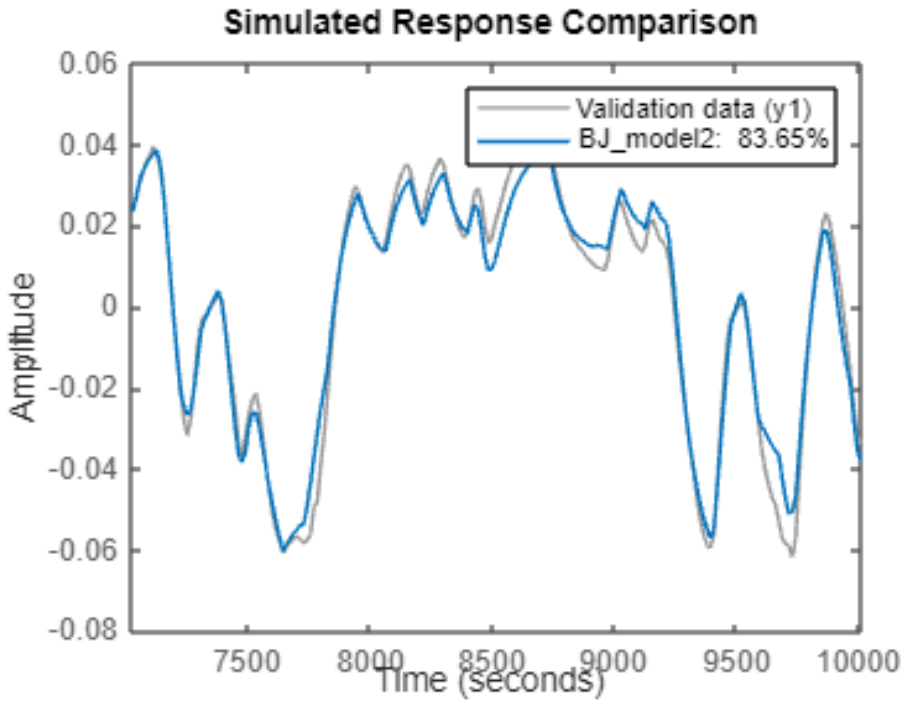

```
compare(ZV_1,BJ_model1)
```




```
BJ_model2 = bj(ZT_2,[[2 3] 1 1 [2 2] nk2_Tf]); % [1 1] 1 1 [1 1]
resid(ZV_2,BJ_model2)
```



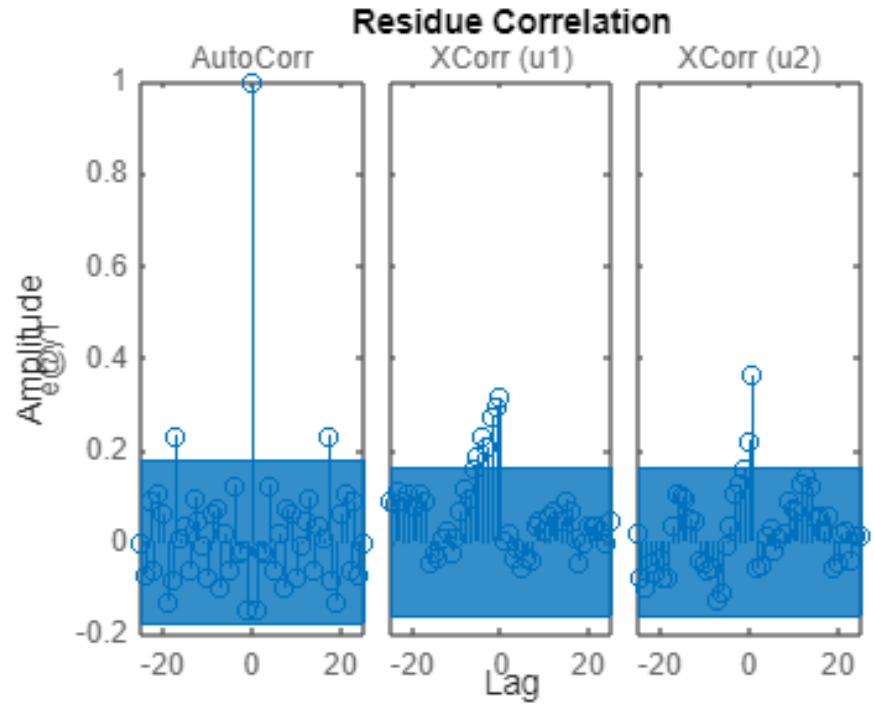

```
compare(ZV_2,BJ_model2)
```



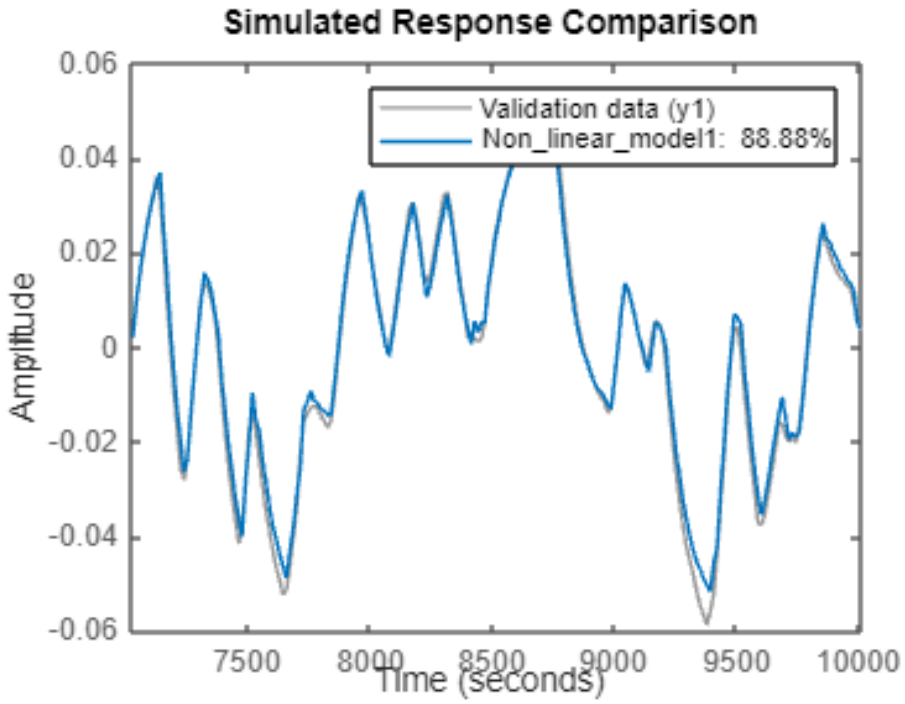

```
% Uinput = [u1,u2];
```

%%% non-linear ARX %%%

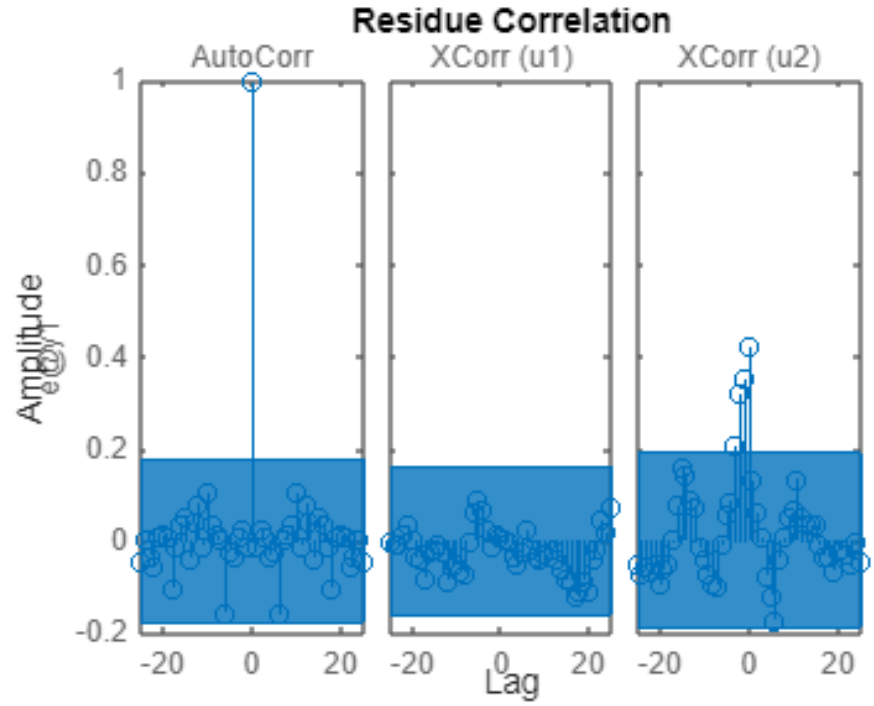
```
Non_linear_model1 = nlarx(ZT_1,[3 [2 2] nk1_Tf]);
resid(ZV_1,Non_linear_model1)
```



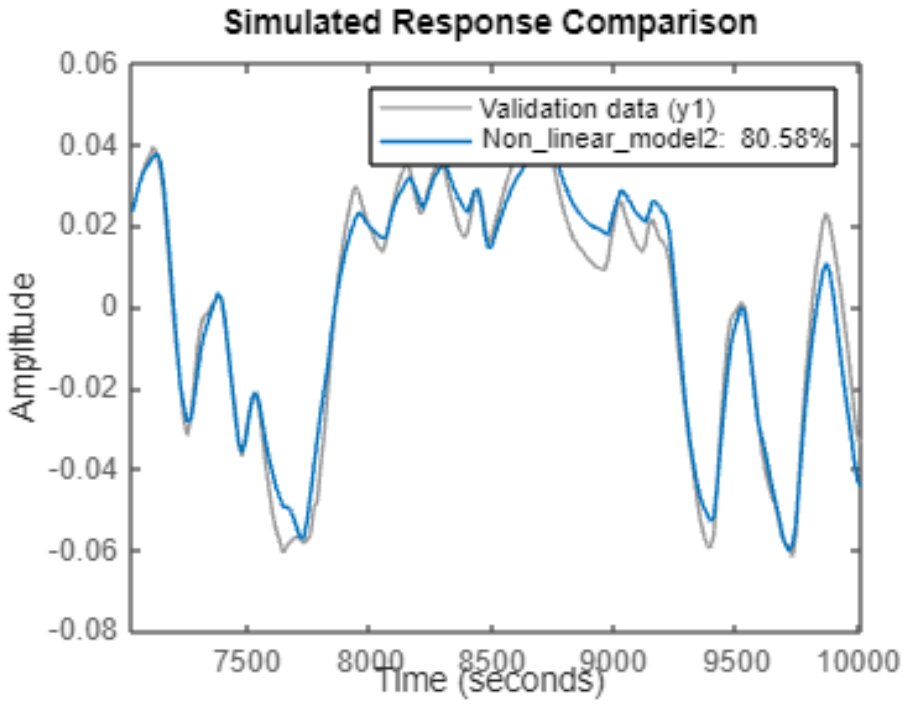

```
compare(ZV_1,Non_linear_model1)
```




```
figure
Non_linear_model2 = nlarx(ZT_2,[3 [2 2] nk2_Tf]);
resid(ZV_2,Non_linear_model2)
```



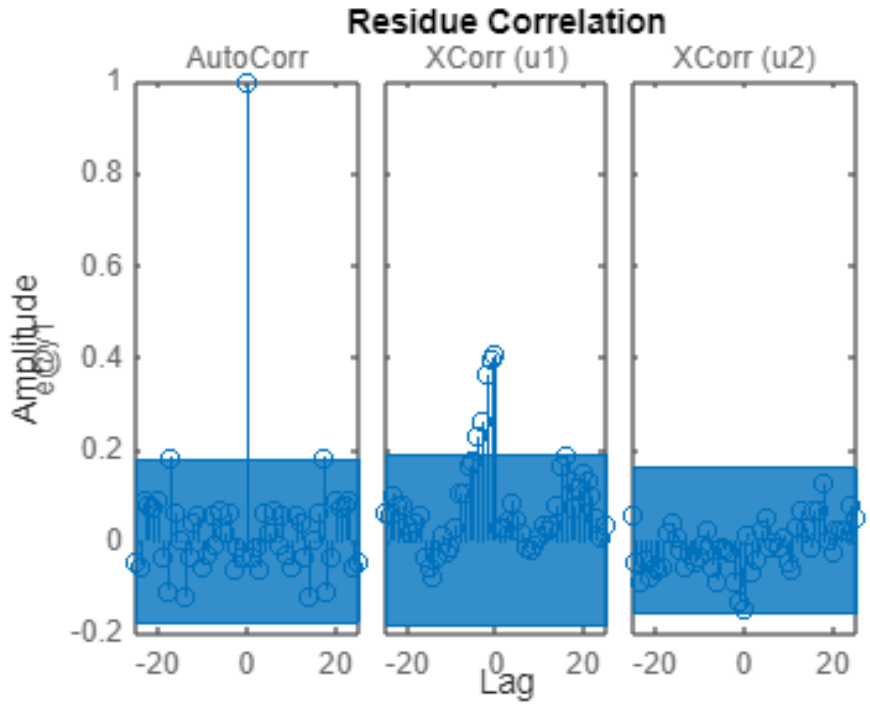

```
compare(ZV_2,Non_linear_model2)
```



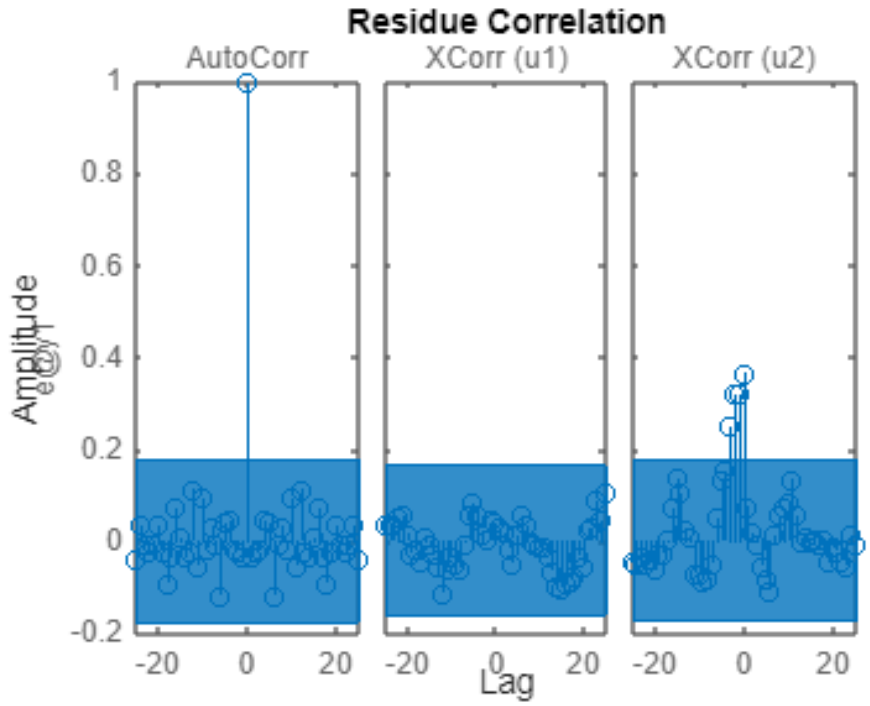

```
Non_linear_model1
```

```
Non_linear_model1 =

Nonlinear ARX model with 1 output and 2 inputs
  Inputs: u1, u2
  Outputs: y1

Regressors:
  Linear regressors in variables y1, u1, u2
  List of all regressors

Output function: Wavelet network with 1 units
Sample time: 14 seconds

Status:
Estimated using NLARX on time domain data "ZT_1".
Fit to estimation data: 94.07% (prediction focus)
FPE: 2.536e-06, MSE: 2.431e-06

Model Properties
```

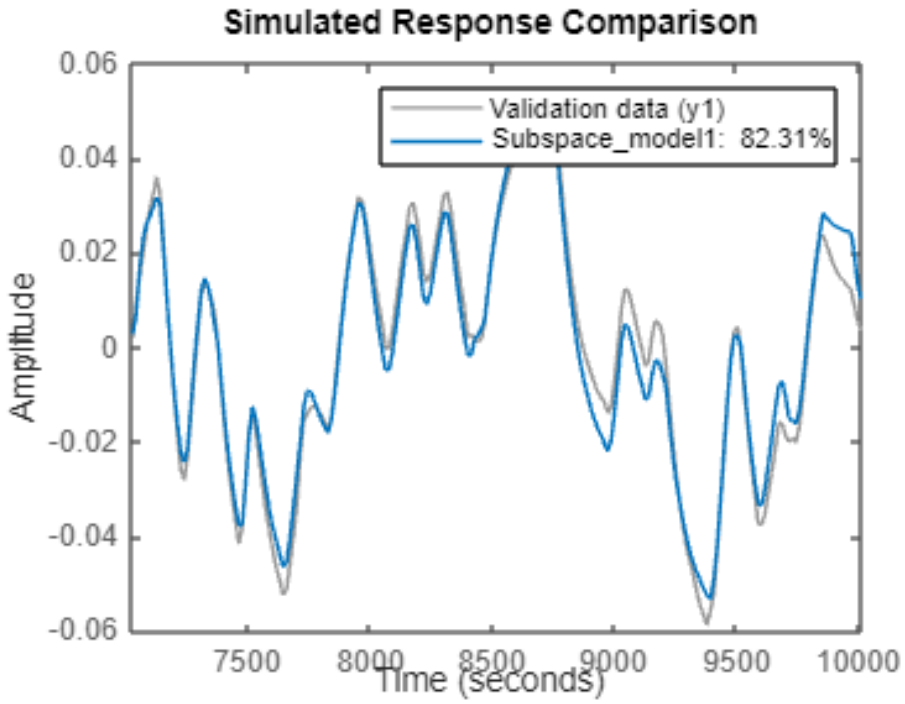
```
%%% subspace %%%
Subspace_model1=n4sid(ZT_1,4);
Sunspace_model2=n4sid(ZT_2,4);
resid(ZV_1,Subspace_model1)
```



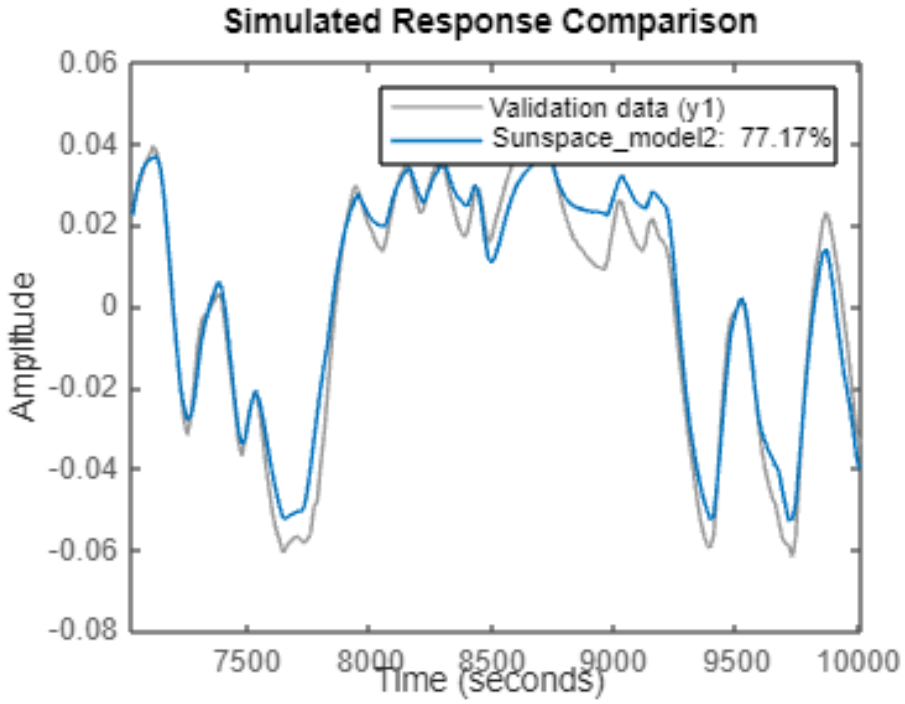

```
resid(ZV_2,Sunspace_model2)
```




```
compare(ZV_1,Subspace_model1)
```




```
figure
compare(ZV_2,Sunspace_model2)
```




```
Subspace_model1
```

```
Subspace_model1 =
  Discrete-time identified state-space model:
    x(t+Ts) = A x(t) + B u(t) + K e(t)
       y(t) = C x(t) + D u(t) + e(t)
```

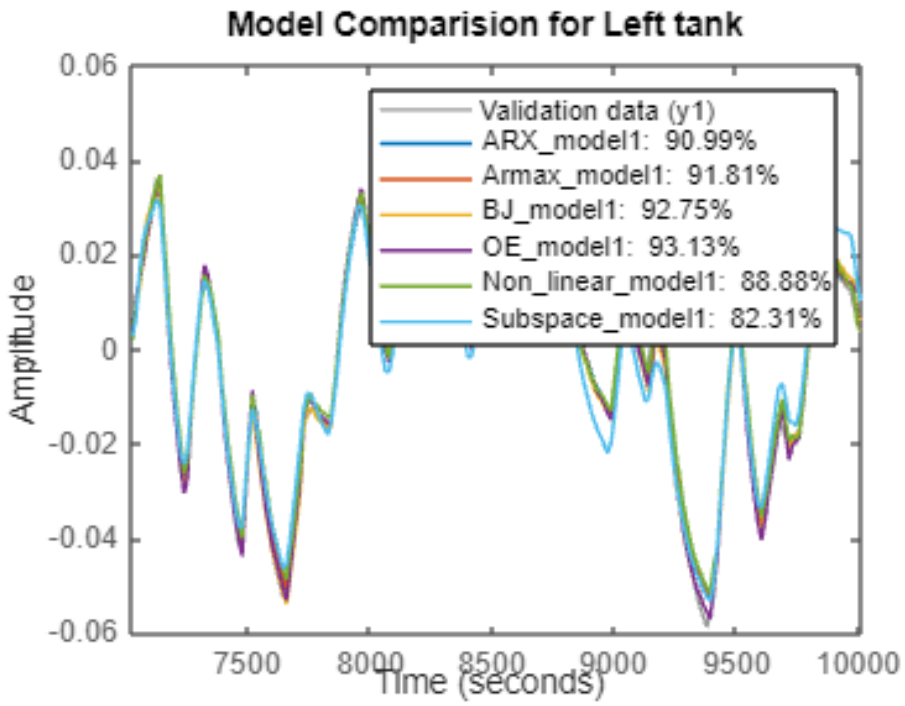
```
  A =
              x1          x2          x3          x4
   x1      0.9063     0.09998   -0.006999    0.003504
   x2     -0.2326      0.4413      0.2022      0.1033
   x3     0.01249     -0.1679      0.1337      0.2189
   x4  -7.045e-05    -0.04419     -0.5162      0.8641

  B =
              u1         u2
   x1  -0.003727  -0.001852
   x2   0.004068    -0.0284
   x3   0.001189  -0.007157
   x4   0.002445  -0.007337

  C =
              x1         x2         x3         x4
   y1    -0.4981   -0.01106  -0.000682   -0.00294

  D =
       u1  u2
   y1   0   0

  K =
            y1
   x1   -2.12
   x2  -4.996
   x3  -3.511
   x4  -16.36

Sample time: 14 seconds

Parameterization:
   FREE form (all coefficients in A, B, C free).
   Feedthrough: none
   Disturbance component: estimate
   Number of free coefficients: 32
   Use "idssdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using N4SID on time domain data "ZT_1".
Fit to estimation data: 95.64% (prediction focus)
FPE: 1.425e-06, MSE: 1.315e-06

Model Properties
```

Sunspace_model2

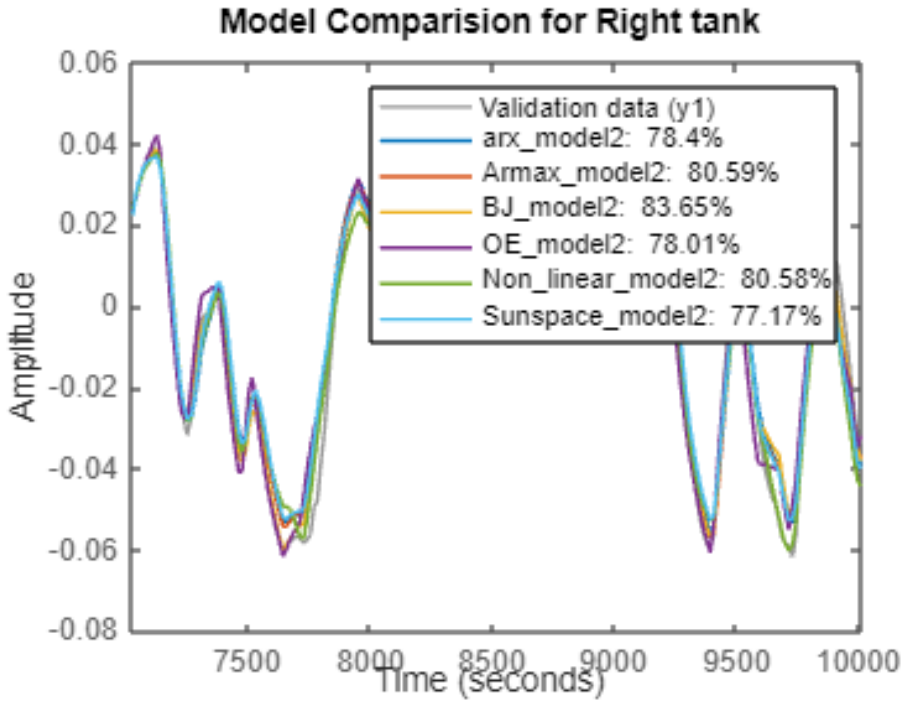
```
Sunspace_model2 =
  Discrete-time identified state-space model:
    x(t+Ts) = A x(t) + B u(t) + K e(t)
       y(t) = C x(t) + D u(t) + e(t)

  A =
              x1          x2          x3          x4
   x1      0.9239      0.1127    0.004036  -6.477e-05
   x2     -0.2531      0.5047   -0.003309     -0.4022
   x3   7.864e-06      0.1272     -0.8463      0.3838
   x4   -0.001261     0.04557      0.6172      0.5899

  B =
              u1          u2
   x1   0.0009058     0.00167
```

```
   x2     0.02331  -0.0002256
   x3    -0.01139    0.007945
   x4    0.001292   -0.001132

  C =
              x1         x2         x3         x4
   y1     0.6314    0.02662  0.0007636  -0.004911

  D =
       u1  u2
   y1   0   0

  K =
          y1
   x1   2.122
   x2   6.101
   x3  -3.144
   x4  -1.629

Sample time: 14 seconds

Parameterization:
   FREE form (all coefficients in A, B, C free).
   Feedthrough: none
   Disturbance component: estimate
   Number of free coefficients: 32
   Use "idssdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using N4SID on time domain data "ZT_2".
Fit to estimation data: 94.62% (prediction focus)
FPE: 3.194e-06, MSE: 2.949e-06

Model Properties
```

```
figure
compare
(ZV_1,ARX_model1,Armax_model1,BJ_model1,OE_model1,Non_linear_model1,Subspace_
model1)
title ('Model Comparision for Left tank ')
```




```
figure
compare
(ZV_2,arx_model2,Armax_model2,BJ_model2,OE_model2,Non_linear_model2,Sunspace_
model2)
title ('Model Comparision for Right tank')
```




```
bode (bode_11, ARX_model1,Armax_model1,BJ_model1,OE_model1,Subspace_model1)
```

```
bode_arx1 =
bode_arx1(:,:,1) =

    0.0139    0.0235


bode_arx1(:,:,2) =

    0.0139    0.0235


bode_arx1(:,:,3) =

    0.0139    0.0235


bode_arx1(:,:,4) =

    0.0139    0.0235


bode_arx1(:,:,5) =

    0.0139    0.0235


bode_arx1(:,:,6) =

    0.0139    0.0235


bode_arx1(:,:,7) =

    0.0139    0.0235


bode_arx1(:,:,8) =

    0.0139    0.0235


bode_arx1(:,:,9) =

    0.0139    0.0235


bode_arx1(:,:,10) =

    0.0139    0.0235


bode_arx1(:,:,11) =

    0.0139    0.0234


bode_arx1(:,:,12) =

    0.0138    0.0234


bode_arx1(:,:,13) =

    0.0138    0.0234
```

```
bode_arx1(:,:,14) =

    0.0138    0.0234

bode_arx1(:,:,15) =

    0.0138    0.0233

bode_arx1(:,:,16) =

    0.0137    0.0232

bode_arx1(:,:,17) =

    0.0137    0.0231

bode_arx1(:,:,18) =

    0.0136    0.0230

bode_arx1(:,:,19) =

    0.0135    0.0228

bode_arx1(:,:,20) =

    0.0134    0.0226

bode_arx1(:,:,21) =

    0.0132    0.0223

bode_arx1(:,:,22) =

    0.0130    0.0219

bode_arx1(:,:,23) =

    0.0127    0.0214

bode_arx1(:,:,24) =

    0.0123    0.0207

bode_arx1(:,:,25) =

    0.0119    0.0199

bode_arx1(:,:,26) =
```

```
    0.0113    0.0190

bode_arx1(:,:,27) =

    0.0107    0.0178

bode_arx1(:,:,28) =

    0.0103    0.0172

bode_arx1(:,:,29) =

    0.0100    0.0166

bode_arx1(:,:,30) =

    0.0092    0.0152

bode_arx1(:,:,31) =

    0.0085    0.0138

bode_arx1(:,:,32) =

    0.0077    0.0124

bode_arx1(:,:,33) =

    0.0069    0.0110

bode_arx1(:,:,34) =

    0.0062    0.0096

bode_arx1(:,:,35) =

    0.0055    0.0084

bode_arx1(:,:,36) =

    0.0050    0.0072

bode_arx1(:,:,37) =

    0.0044    0.0062

bode_arx1(:,:,38) =

    0.0040    0.0052

bode_arx1(:,:,39) =
```

```
    0.0035    0.0044

bode_arx1(:,:,40) =

    0.0032    0.0037

bode_arx1(:,:,41) =

    0.0028    0.0030

bode_arx1(:,:,42) =

    0.0025    0.0024

bode_arx1(:,:,43) =

    0.0021    0.0020

bode_arx1(:,:,44) =

    0.0020    0.0018

bode_arx1(:,:,45) =

    0.0019    0.0017

bode_arx1(:,:,46) =

    0.0017    0.0015

bode_arx1(:,:,47) =

    0.0015    0.0013

bode_arx1(:,:,48) =

    0.0014    0.0012

bode_arx1(:,:,49) =

    0.0014    0.0011

bode_arx1(:,:,50) =

    0.0013    0.0011

bode_arx1(:,:,51) =

    0.0014    0.0011
```

```
bode_arx1(:,:,52) =

    0.0014    0.0011


bode_arx1(:,:,53) =

    0.0014    0.0011


bode_arx1(:,:,54) =

    0.0015    0.0011


bode_arx1(:,:,55) =

    0.0015    0.0011
bode_Armax1 =
bode_Armax1(:,:,1) =

    0.0140    0.0237


bode_Armax1(:,:,2) =

    0.0140    0.0237


bode_Armax1(:,:,3) =

    0.0140    0.0237


bode_Armax1(:,:,4) =

    0.0140    0.0237


bode_Armax1(:,:,5) =

    0.0140    0.0237


bode_Armax1(:,:,6) =

    0.0140    0.0237


bode_Armax1(:,:,7) =

    0.0140    0.0237


bode_Armax1(:,:,8) =

    0.0140    0.0237


bode_Armax1(:,:,9) =

    0.0140    0.0236
```

```
bode_Armax1(:,:,10) =

    0.0140    0.0236

bode_Armax1(:,:,11) =

    0.0140    0.0236

bode_Armax1(:,:,12) =

    0.0140    0.0236

bode_Armax1(:,:,13) =

    0.0140    0.0236

bode_Armax1(:,:,14) =

    0.0139    0.0235

bode_Armax1(:,:,15) =

    0.0139    0.0235

bode_Armax1(:,:,16) =

    0.0139    0.0234

bode_Armax1(:,:,17) =

    0.0138    0.0233

bode_Armax1(:,:,18) =

    0.0137    0.0232

bode_Armax1(:,:,19) =

    0.0136    0.0230

bode_Armax1(:,:,20) =

    0.0135    0.0228

bode_Armax1(:,:,21) =

    0.0133    0.0225

bode_Armax1(:,:,22) =

    0.0131    0.0221
```

```
bode_Armax1(:,:,23) =

    0.0128    0.0216

bode_Armax1(:,:,24) =

    0.0125    0.0209

bode_Armax1(:,:,25) =

    0.0120    0.0201

bode_Armax1(:,:,26) =

    0.0115    0.0192

bode_Armax1(:,:,27) =

    0.0108    0.0181

bode_Armax1(:,:,28) =

    0.0105    0.0175

bode_Armax1(:,:,29) =

    0.0101    0.0168

bode_Armax1(:,:,30) =

    0.0094    0.0154

bode_Armax1(:,:,31) =

    0.0086    0.0140

bode_Armax1(:,:,32) =

    0.0078    0.0125

bode_Armax1(:,:,33) =

    0.0070    0.0111

bode_Armax1(:,:,34) =

    0.0063    0.0097

bode_Armax1(:,:,35) =

    0.0056    0.0084
```

```
bode_Armax1(:,:,36) =

    0.0050    0.0072

bode_Armax1(:,:,37) =

    0.0044    0.0062

bode_Armax1(:,:,38) =

    0.0040    0.0052

bode_Armax1(:,:,39) =

    0.0035    0.0044

bode_Armax1(:,:,40) =

    0.0032    0.0036

bode_Armax1(:,:,41) =

    0.0028    0.0030

bode_Armax1(:,:,42) =

    0.0025    0.0024

bode_Armax1(:,:,43) =

    0.0023    0.0020

bode_Armax1(:,:,44) =

    0.0022    0.0019

bode_Armax1(:,:,45) =

    0.0020    0.0017

bode_Armax1(:,:,46) =

    0.0018    0.0014

bode_Armax1(:,:,47) =

    0.0016    0.0013

bode_Armax1(:,:,48) =
```

```
    0.0015    0.0012


bode_Armax1(:,:,49) =

    0.0014    0.0011


bode_Armax1(:,:,50) =

    0.0014    0.0011
bode_BJ1 =
bode_BJ1(:,:,1) =

    0.0015    0.0230


bode_BJ1(:,:,2) =

    0.0015    0.0230


bode_BJ1(:,:,3) =

    0.0015    0.0230


bode_BJ1(:,:,4) =

    0.0015    0.0230


bode_BJ1(:,:,5) =

    0.0015    0.0230


bode_BJ1(:,:,6) =

    0.0015    0.0230


bode_BJ1(:,:,7) =

    0.0015    0.0230


bode_BJ1(:,:,8) =

    0.0015    0.0230


bode_BJ1(:,:,9) =

    0.0015    0.0230


bode_BJ1(:,:,10) =

    0.0015    0.0230


bode_BJ1(:,:,11) =
```

```
    0.0015    0.0230

bode_BJ1(:,:,12) =

    0.0015    0.0230

bode_BJ1(:,:,13) =

    0.0015    0.0230

bode_BJ1(:,:,14) =

    0.0015    0.0230

bode_BJ1(:,:,15) =

    0.0015    0.0230

bode_BJ1(:,:,16) =

    0.0015    0.0230

bode_BJ1(:,:,17) =

    0.0015    0.0230

bode_BJ1(:,:,18) =

    0.0015    0.0230

bode_BJ1(:,:,19) =

    0.0015    0.0230

bode_BJ1(:,:,20) =

    0.0015    0.0230

bode_BJ1(:,:,21) =

    0.0016    0.0230

bode_BJ1(:,:,22) =

    0.0016    0.0230

bode_BJ1(:,:,23) =

    0.0016    0.0230

bode_BJ1(:,:,24) =
```

```
    0.0017    0.0230

bode_BJ1(:,:,25) =

    0.0017    0.0230

bode_BJ1(:,:,26) =

    0.0018    0.0230

bode_BJ1(:,:,27) =

    0.0019    0.0230

bode_BJ1(:,:,28) =

    0.0020    0.0230

bode_BJ1(:,:,29) =

    0.0021    0.0230

bode_BJ1(:,:,30) =

    0.0022    0.0230

bode_BJ1(:,:,31) =

    0.0024    0.0230

bode_BJ1(:,:,32) =

    0.0027    0.0230

bode_BJ1(:,:,33) =

    0.0030    0.0230

bode_BJ1(:,:,34) =

    0.0034    0.0230

bode_BJ1(:,:,35) =

    0.0038    0.0230

bode_BJ1(:,:,36) =

    0.0044    0.0230
```

```
bode_BJ1(:,:,37) =

    0.0049    0.0230

bode_BJ1(:,:,38) =

    0.0056    0.0230

bode_BJ1(:,:,39) =

    0.0064    0.0230

bode_BJ1(:,:,40) =

    0.0072    0.0230

bode_BJ1(:,:,41) =

    0.0081    0.0230

bode_BJ1(:,:,42) =

    0.0090    0.0230

bode_BJ1(:,:,43) =

    0.0099    0.0229

bode_BJ1(:,:,44) =

    0.0104    0.0229

bode_BJ1(:,:,45) =

    0.0108    0.0229

bode_BJ1(:,:,46) =

    0.0116    0.0229

bode_BJ1(:,:,47) =

    0.0124    0.0228

bode_BJ1(:,:,48) =

    0.0130    0.0228

bode_BJ1(:,:,49) =

    0.0135    0.0227
```

```
bode_BJ1(:,:,50) =

    0.0139    0.0226

bode_BJ1(:,:,51) =

    0.0141    0.0224

bode_BJ1(:,:,52) =

    0.0142    0.0222

bode_BJ1(:,:,53) =

    0.0142    0.0220

bode_BJ1(:,:,54) =

    0.0141    0.0216

bode_BJ1(:,:,55) =

    0.0138    0.0211

bode_BJ1(:,:,56) =

    0.0134    0.0206

bode_BJ1(:,:,57) =

    0.0128    0.0199

bode_BJ1(:,:,58) =

    0.0122    0.0190

bode_BJ1(:,:,59) =

    0.0114    0.0179

bode_BJ1(:,:,60) =

    0.0111    0.0175

bode_BJ1(:,:,61) =

    0.0106    0.0168

bode_BJ1(:,:,62) =

    0.0097    0.0154
```

```
bode_BJ1(:,:,63) =

    0.0088    0.0140

bode_BJ1(:,:,64) =

    0.0079    0.0126

bode_BJ1(:,:,65) =

    0.0071    0.0111

bode_BJ1(:,:,66) =

    0.0063    0.0097

bode_BJ1(:,:,67) =

    0.0056    0.0084

bode_BJ1(:,:,68) =

    0.0050    0.0072

bode_BJ1(:,:,69) =

    0.0044    0.0061

bode_BJ1(:,:,70) =

    0.0040    0.0052

bode_BJ1(:,:,71) =

    0.0036    0.0043

bode_BJ1(:,:,72) =

    0.0033    0.0036

bode_BJ1(:,:,73) =

    0.0030    0.0031

bode_BJ1(:,:,74) =

    0.0028    0.0026

bode_BJ1(:,:,75) =
```

```
    0.0026    0.0022

bode_BJ1(:,:,76) =

    0.0025    0.0021

bode_BJ1(:,:,77) =

    0.0024    0.0019

bode_BJ1(:,:,78) =

    0.0022    0.0017

bode_BJ1(:,:,79) =

    0.0021    0.0015

bode_BJ1(:,:,80) =

    0.0020    0.0014

bode_BJ1(:,:,81) =

    0.0019    0.0013

bode_BJ1(:,:,82) =

    0.0019    0.0013
bode_OE1 =
bode_OE1(:,:,1) =

    0.0140    0.0256

bode_OE1(:,:,2) =

    0.0140    0.0256

bode_OE1(:,:,3) =

    0.0140    0.0256

bode_OE1(:,:,4) =

    0.0140    0.0256

bode_OE1(:,:,5) =

    0.0140    0.0256

bode_OE1(:,:,6) =
```

```
    0.0140    0.0256

bode_OE1(:,:,7) =

    0.0140    0.0256

bode_OE1(:,:,8) =

    0.0140    0.0255

bode_OE1(:,:,9) =

    0.0140    0.0255

bode_OE1(:,:,10) =

    0.0140    0.0255

bode_OE1(:,:,11) =

    0.0140    0.0255

bode_OE1(:,:,12) =

    0.0140    0.0255

bode_OE1(:,:,13) =

    0.0140    0.0255

bode_OE1(:,:,14) =

    0.0140    0.0254

bode_OE1(:,:,15) =

    0.0140    0.0254

bode_OE1(:,:,16) =

    0.0139    0.0253

bode_OE1(:,:,17) =

    0.0139    0.0252

bode_OE1(:,:,18) =

    0.0139    0.0251

bode_OE1(:,:,19) =
```

```
    0.0138    0.0249

bode_OE1(:,:,20) =

    0.0137    0.0247

bode_OE1(:,:,21) =

    0.0136    0.0244

bode_OE1(:,:,22) =

    0.0135    0.0240

bode_OE1(:,:,23) =

    0.0133    0.0234

bode_OE1(:,:,24) =

    0.0130    0.0228

bode_OE1(:,:,25) =

    0.0127    0.0220

bode_OE1(:,:,26) =

    0.0124    0.0210

bode_OE1(:,:,27) =

    0.0119    0.0199

bode_OE1(:,:,28) =

    0.0113    0.0186

bode_OE1(:,:,29) =

    0.0112    0.0182

bode_OE1(:,:,30) =

    0.0107    0.0172

bode_OE1(:,:,31) =

    0.0100    0.0157
```

```
bode_OE1(:,:,32) =

    0.0092    0.0142

bode_OE1(:,:,33) =

    0.0084    0.0127

bode_OE1(:,:,34) =

    0.0076    0.0112

bode_OE1(:,:,35) =

    0.0069    0.0099

bode_OE1(:,:,36) =

    0.0061    0.0086

bode_OE1(:,:,37) =

    0.0055    0.0075

bode_OE1(:,:,38) =

    0.0049    0.0065

bode_OE1(:,:,39) =

    0.0043    0.0056

bode_OE1(:,:,40) =

    0.0039    0.0048

bode_OE1(:,:,41) =

    0.0035    0.0041

bode_OE1(:,:,42) =

    0.0032    0.0035

bode_OE1(:,:,43) =

    0.0029    0.0030

bode_OE1(:,:,44) =

    0.0027    0.0025
```

```
bode_OE1(:,:,45) =

    0.0026    0.0024


bode_OE1(:,:,46) =

    0.0025    0.0021


bode_OE1(:,:,47) =

    0.0024    0.0018


bode_OE1(:,:,48) =

    0.0023    0.0016


bode_OE1(:,:,49) =

    0.0022    0.0014


bode_OE1(:,:,50) =

    0.0022    0.0012


bode_OE1(:,:,51) =

    0.0022    0.0012
bode_SubSpace1 =
bode_SubSpace1(:,:,1) =

    0.0099    0.0281


bode_SubSpace1(:,:,2) =

    0.0099    0.0280


bode_SubSpace1(:,:,3) =

    0.0099    0.0280


bode_SubSpace1(:,:,4) =

    0.0099    0.0280


bode_SubSpace1(:,:,5) =

    0.0099    0.0280


bode_SubSpace1(:,:,6) =

    0.0099    0.0280
```

```
bode_SubSpace1(:,:,7) =

    0.0099    0.0280

bode_SubSpace1(:,:,8) =

    0.0099    0.0280

bode_SubSpace1(:,:,9) =

    0.0099    0.0280

bode_SubSpace1(:,:,10) =

    0.0099    0.0280

bode_SubSpace1(:,:,11) =

    0.0099    0.0279

bode_SubSpace1(:,:,12) =

    0.0099    0.0279

bode_SubSpace1(:,:,13) =

    0.0098    0.0279

bode_SubSpace1(:,:,14) =

    0.0098    0.0278

bode_SubSpace1(:,:,15) =

    0.0098    0.0278

bode_SubSpace1(:,:,16) =

    0.0098    0.0276

bode_SubSpace1(:,:,17) =

    0.0097    0.0275

bode_SubSpace1(:,:,18) =

    0.0097    0.0273

bode_SubSpace1(:,:,19) =

    0.0096    0.0270
```

```
bode_SubSpace1(:,:,20) =

    0.0095    0.0267

bode_SubSpace1(:,:,21) =

    0.0094    0.0262

bode_SubSpace1(:,:,22) =

    0.0093    0.0256

bode_SubSpace1(:,:,23) =

    0.0091    0.0249

bode_SubSpace1(:,:,24) =

    0.0088    0.0239

bode_SubSpace1(:,:,25) =

    0.0085    0.0228

bode_SubSpace1(:,:,26) =

    0.0081    0.0214

bode_SubSpace1(:,:,27) =

    0.0079    0.0207

bode_SubSpace1(:,:,28) =

    0.0077    0.0198

bode_SubSpace1(:,:,29) =

    0.0072    0.0180

bode_SubSpace1(:,:,30) =

    0.0066    0.0161

bode_SubSpace1(:,:,31) =

    0.0061    0.0142

bode_SubSpace1(:,:,32) =
```

```
    0.0055    0.0123

bode_SubSpace1(:,:,33) =

    0.0049    0.0105

bode_SubSpace1(:,:,34) =

    0.0044    0.0089

bode_SubSpace1(:,:,35) =

    0.0039    0.0074

bode_SubSpace1(:,:,36) =

    0.0034    0.0062

bode_SubSpace1(:,:,37) =

    0.0030    0.0050

bode_SubSpace1(:,:,38) =

    0.0027    0.0040

bode_SubSpace1(:,:,39) =

    0.0024    0.0032

bode_SubSpace1(:,:,40) =

    0.0021    0.0024

bode_SubSpace1(:,:,41) =

    0.0018    0.0018

bode_SubSpace1(:,:,42) =

    0.0016    0.0013

bode_SubSpace1(:,:,43) =

    0.0015    0.0012

bode_SubSpace1(:,:,44) =

    0.0014    0.0009

bode_SubSpace1(:,:,45) =
```

```
    0.0013    0.0007

bode_SubSpace1(:,:,46) =

    0.0012    0.0005

bode_SubSpace1(:,:,47) =

    0.0011    0.0005

bode_SubSpace1(:,:,48) =

    0.0011    0.0004

bode_SubSpace1(:,:,49) =

    0.0010    0.0003

bode_SubSpace1(:,:,50) =

    0.0010    0.0003

bode_SubSpace1(:,:,51) =

    0.0010    0.0002

bode_SubSpace1(:,:,52) =

    0.0010    0.0002
bode_arx2 =
bode_arx2(:,:,1) =

    0.0300    0.0066

bode_arx2(:,:,2) =

    0.0300    0.0066

bode_arx2(:,:,3) =

    0.0300    0.0066

bode_arx2(:,:,4) =

    0.0300    0.0066

bode_arx2(:,:,5) =

    0.0300    0.0066

bode_arx2(:,:,6) =
```

```
    0.0300    0.0066

bode_arx2(:,:,7) =

    0.0300    0.0066

bode_arx2(:,:,8) =

    0.0300    0.0066

bode_arx2(:,:,9) =

    0.0299    0.0066

bode_arx2(:,:,10) =

    0.0299    0.0066

bode_arx2(:,:,11) =

    0.0299    0.0066

bode_arx2(:,:,12) =

    0.0299    0.0065

bode_arx2(:,:,13) =

    0.0298    0.0065

bode_arx2(:,:,14) =

    0.0298    0.0065

bode_arx2(:,:,15) =

    0.0297    0.0065

bode_arx2(:,:,16) =

    0.0296    0.0065

bode_arx2(:,:,17) =

    0.0295    0.0065

bode_arx2(:,:,18) =

    0.0293    0.0065
```

```
bode_arx2(:,:,19) =

    0.0290    0.0064

bode_arx2(:,:,20) =

    0.0287    0.0064

bode_arx2(:,:,21) =

    0.0282    0.0063

bode_arx2(:,:,22) =

    0.0277    0.0062

bode_arx2(:,:,23) =

    0.0269    0.0061

bode_arx2(:,:,24) =

    0.0260    0.0059

bode_arx2(:,:,25) =

    0.0248    0.0058

bode_arx2(:,:,26) =

    0.0234    0.0055

bode_arx2(:,:,27) =

    0.0228    0.0054

bode_arx2(:,:,28) =

    0.0217    0.0053

bode_arx2(:,:,29) =

    0.0199    0.0050

bode_arx2(:,:,30) =

    0.0179    0.0047

bode_arx2(:,:,31) =

    0.0157    0.0043
```

```
bode_arx2(:,:,32) =

    0.0136    0.0039

bode_arx2(:,:,33) =

    0.0115    0.0036

bode_arx2(:,:,34) =

    0.0095    0.0032

bode_arx2(:,:,35) =

    0.0078    0.0028

bode_arx2(:,:,36) =

    0.0063    0.0025

bode_arx2(:,:,37) =

    0.0050    0.0022

bode_arx2(:,:,38) =

    0.0039    0.0019

bode_arx2(:,:,39) =

    0.0030    0.0016

bode_arx2(:,:,40) =

    0.0023    0.0013

bode_arx2(:,:,41) =

    0.0018    0.0011

bode_arx2(:,:,42) =

    0.0014    0.0009

bode_arx2(:,:,43) =

    0.0013    0.0009

bode_arx2(:,:,44) =

    0.0010    0.0008
```

```
bode_arx2(:,:,45) =

   1.0e-03 *

    0.7687    0.6507

bode_arx2(:,:,46) =

   1.0e-03 *

    0.5901    0.5889

bode_arx2(:,:,47) =

   1.0e-03 *

    0.4635    0.5587

bode_arx2(:,:,48) =

   1.0e-03 *

    0.3635    0.5442

bode_arx2(:,:,49) =

   1.0e-03 *

    0.2830    0.5381

bode_arx2(:,:,50) =

   1.0e-03 *

    0.2180    0.5360

bode_arx2(:,:,51) =

   1.0e-03 *

    0.1663    0.5356

bode_arx2(:,:,52) =

   1.0e-03 *

    0.1279    0.5356

bode_arx2(:,:,53) =

   1.0e-03 *

    0.1044    0.5358
```

```
bode_arx2(:,:,54) =

   1.0e-03 *

    0.0970    0.5358
bode_Armax2 =
bode_Armax2(:,:,1) =

    0.0297    0.0085


bode_Armax2(:,:,2) =

    0.0297    0.0085


bode_Armax2(:,:,3) =

    0.0297    0.0085


bode_Armax2(:,:,4) =

    0.0297    0.0085


bode_Armax2(:,:,5) =

    0.0297    0.0085


bode_Armax2(:,:,6) =

    0.0297    0.0085


bode_Armax2(:,:,7) =

    0.0296    0.0085


bode_Armax2(:,:,8) =

    0.0296    0.0085


bode_Armax2(:,:,9) =

    0.0296    0.0085


bode_Armax2(:,:,10) =

    0.0296    0.0084


bode_Armax2(:,:,11) =

    0.0296    0.0084


bode_Armax2(:,:,12) =
```

```
    0.0296    0.0084

bode_Armax2(:,:,13) =

    0.0295    0.0084

bode_Armax2(:,:,14) =

    0.0295    0.0084

bode_Armax2(:,:,15) =

    0.0294    0.0084

bode_Armax2(:,:,16) =

    0.0293    0.0084

bode_Armax2(:,:,17) =

    0.0292    0.0083

bode_Armax2(:,:,18) =

    0.0291    0.0083

bode_Armax2(:,:,19) =

    0.0288    0.0082

bode_Armax2(:,:,20) =

    0.0286    0.0082

bode_Armax2(:,:,21) =

    0.0282    0.0081

bode_Armax2(:,:,22) =

    0.0277    0.0079

bode_Armax2(:,:,23) =

    0.0270    0.0078

bode_Armax2(:,:,24) =

    0.0262    0.0076

bode_Armax2(:,:,25) =
```

```
    0.0253    0.0073

bode_Armax2(:,:,26) =

    0.0240    0.0070

bode_Armax2(:,:,27) =

    0.0226    0.0066

bode_Armax2(:,:,28) =

    0.0222    0.0065

bode_Armax2(:,:,29) =

    0.0210    0.0062

bode_Armax2(:,:,30) =

    0.0193    0.0058

bode_Armax2(:,:,31) =

    0.0174    0.0053

bode_Armax2(:,:,32) =

    0.0155    0.0048

bode_Armax2(:,:,33) =

    0.0135    0.0043

bode_Armax2(:,:,34) =

    0.0117    0.0038

bode_Armax2(:,:,35) =

    0.0099    0.0034

bode_Armax2(:,:,36) =

    0.0082    0.0030

bode_Armax2(:,:,37) =

    0.0068    0.0026
```

```
bode_Armax2(:,:,38) =

    0.0054    0.0023

bode_Armax2(:,:,39) =

    0.0043    0.0020

bode_Armax2(:,:,40) =

    0.0033    0.0017

bode_Armax2(:,:,41) =

    0.0025    0.0015

bode_Armax2(:,:,42) =

    0.0018    0.0013

bode_Armax2(:,:,43) =

    0.0013    0.0011

bode_Armax2(:,:,44) =

    0.0012    0.0011

bode_Armax2(:,:,45) =

   1.0e-03 *

    0.9102    0.9488

bode_Armax2(:,:,46) =

   1.0e-03 *

    0.6339    0.8215

bode_Armax2(:,:,47) =

   1.0e-03 *

    0.4313    0.7126

bode_Armax2(:,:,48) =

   1.0e-03 *

    0.4076    0.6983

bode_Armax2(:,:,49) =
```

```
   1.0e-03 *

    0.3107    0.6346


bode_Armax2(:,:,50) =

   1.0e-03 *

    0.2529    0.5891


bode_Armax2(:,:,51) =

   1.0e-03 *

    0.2217    0.5594


bode_Armax2(:,:,52) =

   1.0e-03 *

    0.2073    0.5431


bode_Armax2(:,:,53) =

   1.0e-03 *

    0.2033    0.5381
bode_BJ2 =
bode_BJ2(:,:,1) =

    0.0291    0.0064


bode_BJ2(:,:,2) =

    0.0291    0.0064


bode_BJ2(:,:,3) =

    0.0291    0.0064


bode_BJ2(:,:,4) =

    0.0291    0.0064


bode_BJ2(:,:,5) =

    0.0291    0.0064


bode_BJ2(:,:,6) =

    0.0291    0.0064


bode_BJ2(:,:,7) =
```

```
    0.0291    0.0064

bode_BJ2(:,:,8) =

    0.0291    0.0064

bode_BJ2(:,:,9) =

    0.0291    0.0064

bode_BJ2(:,:,10) =

    0.0291    0.0064

bode_BJ2(:,:,11) =

    0.0291    0.0064

bode_BJ2(:,:,12) =

    0.0291    0.0065

bode_BJ2(:,:,13) =

    0.0290    0.0065

bode_BJ2(:,:,14) =

    0.0290    0.0065

bode_BJ2(:,:,15) =

    0.0290    0.0066

bode_BJ2(:,:,16) =

    0.0290    0.0066

bode_BJ2(:,:,17) =

    0.0290    0.0067

bode_BJ2(:,:,18) =

    0.0289    0.0067

bode_BJ2(:,:,19) =

    0.0289    0.0069
```

```
bode_BJ2(:,:,20) =

    0.0288    0.0070

bode_BJ2(:,:,21) =

    0.0287    0.0072

bode_BJ2(:,:,22) =

    0.0286    0.0074

bode_BJ2(:,:,23) =

    0.0284    0.0077

bode_BJ2(:,:,24) =

    0.0281    0.0079

bode_BJ2(:,:,25) =

    0.0278    0.0082

bode_BJ2(:,:,26) =

    0.0274    0.0084

bode_BJ2(:,:,27) =

    0.0268    0.0086

bode_BJ2(:,:,28) =

    0.0261    0.0086

bode_BJ2(:,:,29) =

    0.0252    0.0086

bode_BJ2(:,:,30) =

    0.0241    0.0084

bode_BJ2(:,:,31) =

    0.0228    0.0081

bode_BJ2(:,:,32) =

    0.0220    0.0079
```

```
bode_BJ2(:,:,33) =

    0.0212    0.0076

bode_BJ2(:,:,34) =

    0.0195    0.0071

bode_BJ2(:,:,35) =

    0.0176    0.0065

bode_BJ2(:,:,36) =

    0.0157    0.0059

bode_BJ2(:,:,37) =

    0.0137    0.0053

bode_BJ2(:,:,38) =

    0.0118    0.0047

bode_BJ2(:,:,39) =

    0.0099    0.0041

bode_BJ2(:,:,40) =

    0.0082    0.0036

bode_BJ2(:,:,41) =

    0.0067    0.0031

bode_BJ2(:,:,42) =

    0.0054    0.0027

bode_BJ2(:,:,43) =

    0.0043    0.0024

bode_BJ2(:,:,44) =

    0.0033    0.0021

bode_BJ2(:,:,45) =

    0.0025    0.0018
```

```
bode_BJ2(:,:,46) =

    0.0019    0.0016

bode_BJ2(:,:,47) =

    0.0014    0.0014

bode_BJ2(:,:,48) =

    0.0013    0.0014

bode_BJ2(:,:,49) =

    0.0010    0.0012

bode_BJ2(:,:,50) =

    0.0008    0.0011

bode_BJ2(:,:,51) =

    0.0006    0.0011

bode_BJ2(:,:,52) =

    0.0005    0.0010

bode_BJ2(:,:,53) =

   1.0e-03 *

    0.4166    0.9796

bode_BJ2(:,:,54) =

   1.0e-03 *

    0.3506    0.9525

bode_BJ2(:,:,55) =

   1.0e-03 *

    0.3077    0.9358

bode_BJ2(:,:,56) =

   1.0e-03 *

    0.2842    0.9270
```

```
bode_BJ2(:,:,57) =

   1.0e-03 *

    0.2771    0.9244
bode_OE2 =
bode_OE2(:,:,1) =

    0.0330    0.0123


bode_OE2(:,:,2) =

    0.0330    0.0123


bode_OE2(:,:,3) =

    0.0330    0.0123


bode_OE2(:,:,4) =

    0.0330    0.0123


bode_OE2(:,:,5) =

    0.0330    0.0123


bode_OE2(:,:,6) =

    0.0330    0.0123


bode_OE2(:,:,7) =

    0.0330    0.0123


bode_OE2(:,:,8) =

    0.0330    0.0123


bode_OE2(:,:,9) =

    0.0330    0.0123


bode_OE2(:,:,10) =

    0.0330    0.0123


bode_OE2(:,:,11) =

    0.0329    0.0123


bode_OE2(:,:,12) =
```

```
    0.0329    0.0123

bode_OE2(:,:,13) =

    0.0328    0.0122

bode_OE2(:,:,14) =

    0.0328    0.0122

bode_OE2(:,:,15) =

    0.0328    0.0122

bode_OE2(:,:,16) =

    0.0327    0.0122

bode_OE2(:,:,17) =

    0.0325    0.0122

bode_OE2(:,:,18) =

    0.0324    0.0121

bode_OE2(:,:,19) =

    0.0321    0.0121

bode_OE2(:,:,20) =

    0.0318    0.0120

bode_OE2(:,:,21) =

    0.0314    0.0119

bode_OE2(:,:,22) =

    0.0309    0.0118

bode_OE2(:,:,23) =

    0.0302    0.0117

bode_OE2(:,:,24) =

    0.0293    0.0115

bode_OE2(:,:,25) =
```

```
    0.0282    0.0112

bode_OE2(:,:,26) =

    0.0270    0.0109

bode_OE2(:,:,27) =

    0.0254    0.0104

bode_OE2(:,:,28) =

    0.0238    0.0100

bode_OE2(:,:,29) =

    0.0219    0.0094

bode_OE2(:,:,30) =

    0.0211    0.0091

bode_OE2(:,:,31) =

    0.0200    0.0087

bode_OE2(:,:,32) =

    0.0180    0.0081

bode_OE2(:,:,33) =

    0.0161    0.0073

bode_OE2(:,:,34) =

    0.0142    0.0066

bode_OE2(:,:,35) =

    0.0125    0.0059

bode_OE2(:,:,36) =

    0.0109    0.0052

bode_OE2(:,:,37) =

    0.0095    0.0046
```

```
bode_OE2(:,:,38) =

    0.0083    0.0040

bode_OE2(:,:,39) =

    0.0072    0.0035

bode_OE2(:,:,40) =

    0.0062    0.0030

bode_OE2(:,:,41) =

    0.0054    0.0026

bode_OE2(:,:,42) =

    0.0046    0.0023

bode_OE2(:,:,43) =

    0.0040    0.0020

bode_OE2(:,:,44) =

    0.0035    0.0017

bode_OE2(:,:,45) =

    0.0031    0.0015

bode_OE2(:,:,46) =

    0.0030    0.0015

bode_OE2(:,:,47) =

    0.0027    0.0013

bode_OE2(:,:,48) =

    0.0024    0.0012

bode_OE2(:,:,49) =

    0.0022    0.0011

bode_OE2(:,:,50) =

    0.0021    0.0010
```

```
bode_OE2(:,:,51) =

    0.0020    0.0010


bode_OE2(:,:,52) =

    0.0019    0.0010
bode_SubSpace2 =
bode_SubSpace2(:,:,1) =

    0.0306    0.0063


bode_SubSpace2(:,:,2) =

    0.0306    0.0063


bode_SubSpace2(:,:,3) =

    0.0306    0.0063


bode_SubSpace2(:,:,4) =

    0.0306    0.0063


bode_SubSpace2(:,:,5) =

    0.0306    0.0063


bode_SubSpace2(:,:,6) =

    0.0306    0.0063


bode_SubSpace2(:,:,7) =

    0.0306    0.0062


bode_SubSpace2(:,:,8) =

    0.0305    0.0062


bode_SubSpace2(:,:,9) =

    0.0305    0.0062


bode_SubSpace2(:,:,10) =

    0.0305    0.0062


bode_SubSpace2(:,:,11) =

    0.0305    0.0062
```

```
bode_SubSpace2(:,:,12) =

    0.0305    0.0062

bode_SubSpace2(:,:,13) =

    0.0304    0.0062

bode_SubSpace2(:,:,14) =

    0.0304    0.0062

bode_SubSpace2(:,:,15) =

    0.0303    0.0062

bode_SubSpace2(:,:,16) =

    0.0303    0.0062

bode_SubSpace2(:,:,17) =

    0.0301    0.0062

bode_SubSpace2(:,:,18) =

    0.0300    0.0062

bode_SubSpace2(:,:,19) =

    0.0298    0.0061

bode_SubSpace2(:,:,20) =

    0.0295    0.0061

bode_SubSpace2(:,:,21) =

    0.0291    0.0060

bode_SubSpace2(:,:,22) =

    0.0287    0.0059

bode_SubSpace2(:,:,23) =

    0.0280    0.0058

bode_SubSpace2(:,:,24) =

    0.0273    0.0057
```

```
bode_SubSpace2(:,:,25) =

    0.0263    0.0056

bode_SubSpace2(:,:,26) =

    0.0252    0.0054

bode_SubSpace2(:,:,27) =

    0.0239    0.0052

bode_SubSpace2(:,:,28) =

    0.0224    0.0050

bode_SubSpace2(:,:,29) =

    0.0216    0.0048

bode_SubSpace2(:,:,30) =

    0.0208    0.0047

bode_SubSpace2(:,:,31) =

    0.0191    0.0045

bode_SubSpace2(:,:,32) =

    0.0173    0.0042

bode_SubSpace2(:,:,33) =

    0.0156    0.0040

bode_SubSpace2(:,:,34) =

    0.0138    0.0037

bode_SubSpace2(:,:,35) =

    0.0121    0.0034

bode_SubSpace2(:,:,36) =

    0.0104    0.0031

bode_SubSpace2(:,:,37) =
```

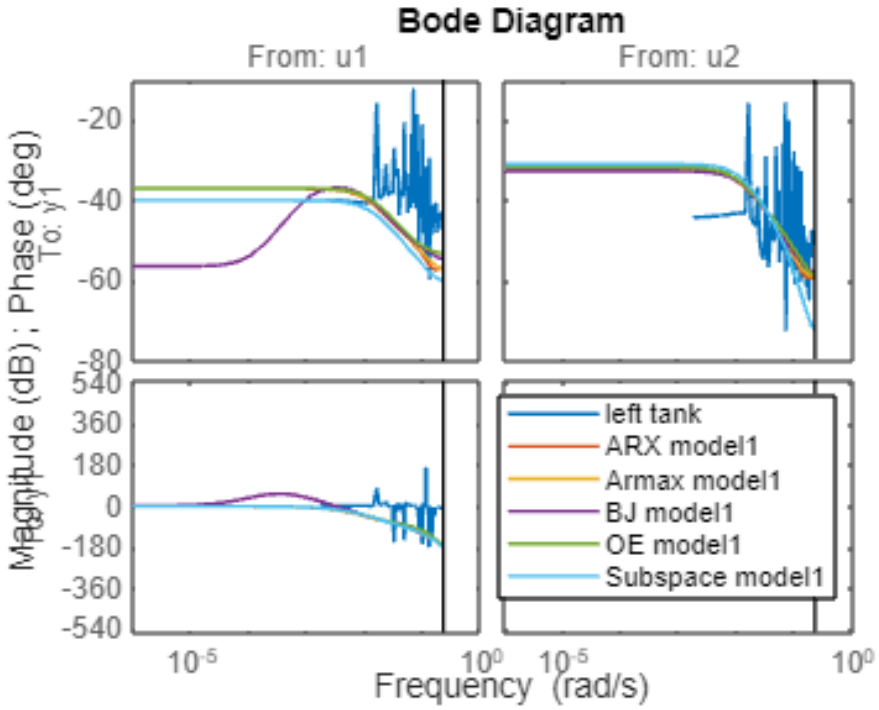
```
    0.0087    0.0028

bode_SubSpace2(:,:,38) =

    0.0070    0.0025

bode_SubSpace2(:,:,39) =

    0.0055    0.0021

bode_SubSpace2(:,:,40) =

    0.0042    0.0018

bode_SubSpace2(:,:,41) =

    0.0032    0.0015

bode_SubSpace2(:,:,42) =

    0.0024    0.0013

bode_SubSpace2(:,:,43) =

    0.0017    0.0011

bode_SubSpace2(:,:,44) =

    0.0013    0.0009

bode_SubSpace2(:,:,45) =

    0.0011    0.0009

bode_SubSpace2(:,:,46) =

   1.0e-03 *

    0.8987    0.7798

bode_SubSpace2(:,:,47) =

   1.0e-03 *

    0.6636    0.6914

bode_SubSpace2(:,:,48) =

   1.0e-03 *

    0.5708    0.6557
```

```
bode_SubSpace2(:,:,49) =

   1.0e-03 *

    0.4635    0.6143

bode_SubSpace2(:,:,50) =

   1.0e-03 *

    0.3894    0.5859

bode_SubSpace2(:,:,51) =

   1.0e-03 *

    0.3378    0.5664

bode_SubSpace2(:,:,52) =

   1.0e-03 *

    0.3022    0.5531

bode_SubSpace2(:,:,53) =

   1.0e-03 *

    0.2787    0.5442

bode_SubSpace2(:,:,54) =

   1.0e-03 *

    0.2649    0.5384

bode_SubSpace2(:,:,55) =

   1.0e-03 *

    0.2599    0.5350

bode_SubSpace2(:,:,56) =

   1.0e-03 *

    0.2645    0.5335

bode_SubSpace2(:,:,57) =

   1.0e-03 *

    0.2822    0.5342

bode_SubSpace2(:,:,58) =
```

```
   1.0e-03 *

    0.3218    0.5383


bode_SubSpace2(:,:,59) =

   1.0e-03 *

    0.4061    0.5499


bode_SubSpace2(:,:,60) =

   1.0e-03 *

    0.6020    0.5868


bode_SubSpace2(:,:,61) =

    0.0012    0.0008


bode_SubSpace2(:,:,62) =

    0.0047    0.0022
```

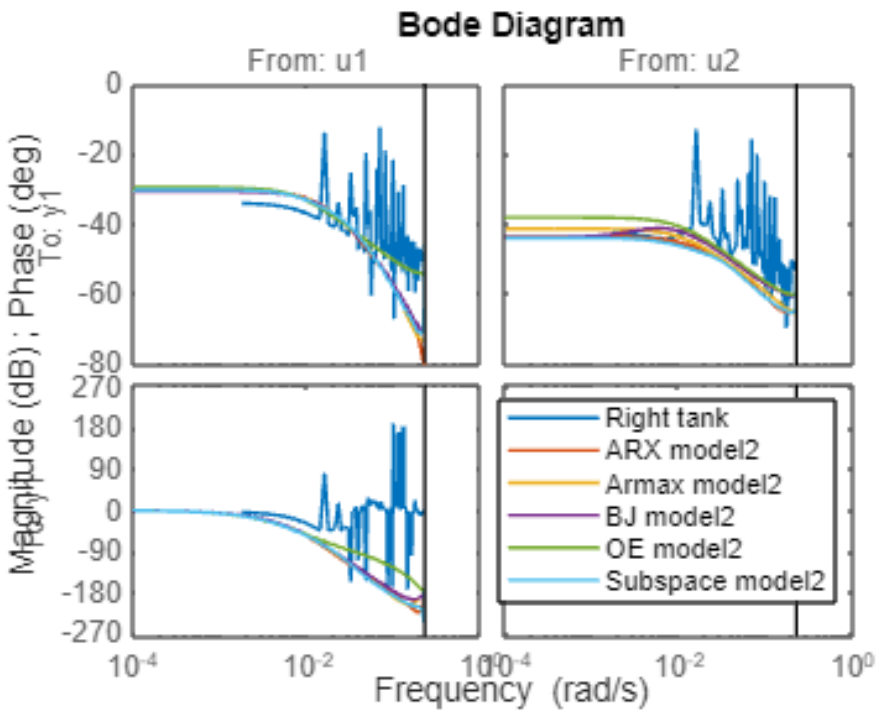
```
Error using compare (line 274)
No valid dataset found for the "compare" command. Specify a dataset using an iddata object, a
timetable object, idfrd object, or numeric matrices.
```

```
legend ('left tank ', 'ARX model1','Armax model1','BJ model1','OE
model1','Subspace model1')
```




```
bode (bode_12, arx_model2,Armax_model2,BJ_model2,OE_model2,Sunspace_model2)
```

```
legend ('Right tank ', 'ARX model2','Armax model2','BJ model2','OE
model2','Subspace model2')
```




```
AIC_arx1 = aic(ARX_model1)
```

```
AIC_arx1 = -12.8794
```

```
Aic_Armax1 =  aic(Armax_model1)
```

```
Aic_Armax1 = -12.8963
```

```
Aic_BJ1  = aic(BJ_model1)
```

```
Aic_BJ1 = -12.9521
```

```
Aic_OE1 = aic(OE_model1)
```

```
Aic_OE1 = -11.7877
```

```
Aic_nonlinear1 = aic(Non_linear_model1)
```

```
Aic_nonlinear1 = -12.8850
```

```
Aic_SubSpace1 = aic (Subspace_model1)
```

```
Aic_SubSpace1 = -13.4615
```

```
aic ( arx_model2,Armax_model2,BJ_model2,OE_model2,Non_linear_model1,
Sunspace_model2)
```

```
Model quality according to the "nAIC" measure:
  -12.6629  -12.6304  -12.5187   -9.3777  -12.8850  -12.6541
```

```
%legend ('Right tank ', 'ARX model2','Armax model2','BJ model2','OE
model2','Subspace model2')
```

ARX_model1

```
ARX_model1 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 0.8597 z^-1

  B1(z) = 0.002344 z^-1 - 0.0001614 z^-2 - 1.331e-05 z^-3 - 0.0002197 z^-4

  B2(z) = 0.002304 z^-2 + 0.0006438 z^-3 + 0.0003515 z^-4

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   na=1   nb=[4 3]   nk=[1 2]
   Number of free coefficients: 8
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "ZT_1".
Fit to estimation data: 94.07% (prediction focus)
FPE: 2.55e-06, MSE: 2.431e-06

Model Properties
```

Armax_model1

```
Armax_model1 =
Discrete-time ARMAX model: A(z)y(t) = B(z)u(t) + C(z)e(t)
  A(z) = 1 - 1.126 z^-1 + 0.2306 z^-2

  B1(z) = 0.002476 z^-1 - 0.0008714 z^-2 - 0.0001329 z^-3

  B2(z) = 0.002411 z^-2 - 6.512e-05 z^-3 + 0.0001405 z^-4

  C(z) = 1 - 0.3638 z^-1

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[3 3]   nc=1   nk=[1 2]
   Number of free coefficients: 9
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARMAX on time domain data "ZT_1".
Fit to estimation data: 94.08% (prediction focus)
FPE: 2.507e-06, MSE: 2.419e-06

Model Properties
```

BJ_model1

```
BJ_model1 =
Discrete-time BJ model: y(t) = [B(z)/F(z)]u(t) + [C(z)/D(z)]e(t)
  B1(z) = 0.002888 z^-1 - 0.003613 z^-2 + 0.0005542 z^-3 + 0.0001738 z^-4

  B2(z) = 0.002647 z^-2 - 0.000972 z^-3
```

```
  C(z) = 1 - 1.488 z^-1 + 0.5047 z^-2

  D(z) = 1 - 1.942 z^-1 + 0.9439 z^-2

  F1(z) = 1 - 1.859 z^-1 + 0.8606 z^-2

  F2(z) = 1 - 1.376 z^-1 + 0.4493 z^-2

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   nb=[4 2]   nc=2   nd=2   nf=[2 2]   nk=[1 2]
   Number of free coefficients: 14
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using BJ on time domain data "ZT_1".
Fit to estimation data: 94.3% (prediction focus)
FPE: 2.371e-06, MSE: 2.242e-06

Model Properties
```

OE_model1

```
OE_model1 =
Discrete-time OE model: y(t) = [B(z)/F(z)]u(t) + e(t)
  B1(z) = 0.003157 z^-1 - 0.000838 z^-2

  B2(z) = 0.002767 z^-2 + 0.0006091 z^-3

  F1(z) = 1 - 0.8346 z^-1

  F2(z) = 1 - 0.868 z^-1

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   nb=[2 2]   nf=[1 1]   nk=[1 2]
   Number of free coefficients: 6
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using OE on time domain data "ZT_1".
Fit to estimation data: 89.64%
FPE: 7.597e-06, MSE: 7.418e-06

Model Properties
```

Non_linear_model1

```
Non_linear_model1 =

Nonlinear ARX model with 1 output and 2 inputs
  Inputs: u1, u2
  Outputs: y1

Regressors:
  Linear regressors in variables y1, u1, u2
  List of all regressors

Output function: Wavelet network with 1 units
Sample time: 14 seconds
```

```
Status:
Estimated using NLARX on time domain data "ZT_1".
Fit to estimation data: 94.07% (prediction focus)
FPE: 2.536e-06, MSE: 2.431e-06

Model Properties
```

Subspace_model1

```
Subspace_model1 =
  Discrete-time identified state-space model:
    x(t+Ts) = A x(t) + B u(t) + K e(t)
       y(t) = C x(t) + D u(t) + e(t)

  A =
              x1          x2          x3          x4
   x1      0.9063     0.09998   -0.006999    0.003504
   x2     -0.2326      0.4413      0.2022      0.1033
   x3     0.01249     -0.1679      0.1337      0.2189
   x4  -7.045e-05    -0.04419     -0.5162      0.8641

  B =
              u1         u2
   x1  -0.003727  -0.001852
   x2   0.004068    -0.0284
   x3   0.001189  -0.007157
   x4   0.002445  -0.007337

  C =
              x1         x2         x3         x4
   y1    -0.4981   -0.01106  -0.000682   -0.00294

  D =
       u1  u2
   y1   0   0

  K =
          y1
   x1   -2.12
   x2  -4.996
   x3  -3.511
   x4  -16.36

Sample time: 14 seconds

Parameterization:
   FREE form (all coefficients in A, B, C free).
   Feedthrough: none
   Disturbance component: estimate
   Number of free coefficients: 32
   Use "idssdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using N4SID on time domain data "ZT_1".
Fit to estimation data: 95.64% (prediction focus)
FPE: 1.425e-06, MSE: 1.315e-06

Model Properties
```

arx_model2

```
arx_model2 =
Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
  A(z) = 1 - 1.498 z^-1 + 0.5548 z^-2

  B1(z) = 0.001214 z^-1 + 0.0007045 z^-2 - 0.0002132 z^-3

  B2(z) = 0.001049 z^-1 - 0.0005443 z^-2 - 4.502e-05 z^-3 - 8.695e-05 z^-4

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[3 4]   nk=[1 1]
   Number of free coefficients: 9
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARX on time domain data "ZT_2".
Fit to estimation data: 94.56% (prediction focus)
FPE: 3.167e-06, MSE: 3.006e-06

Model Properties
```

Armax_model2

```
Armax_model2 =
Discrete-time ARMAX model: A(z)y(t) = B(z)u(t) + C(z)e(t)
  A(z) = 1 - 1.338 z^-1 + 0.4157 z^-2

  B1(z) = 0.001217 z^-1 + 0.0008714 z^-2 + 0.0002138 z^-3

  B2(z) = 0.001196 z^-1 - 0.0004124 z^-2 - 0.0001266 z^-3

  C(z) = 1 + 0.1536 z^-1

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   na=2   nb=[3 3]   nc=1   nk=[1 1]
   Number of free coefficients: 9
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using ARMAX on time domain data "ZT_2".
Fit to estimation data: 94.46% (prediction focus)
FPE: 3.271e-06, MSE: 3.118e-06

Model Properties
```

BJ_model2

```
BJ_model2 =
Discrete-time BJ model: y(t) = [B(z)/F(z)]u(t) + [C(z)/D(z)]e(t)
  B1(z) = 0.001426 z^-1 + 0.0006327 z^-2

  B2(z) = 0.001627 z^-1 - 0.001639 z^-2 + 6.872e-05 z^-3

  C(z) = 1 + 0.3151 z^-1

  D(z) = 1 - 0.9739 z^-1

  F1(z) = 1 - 1.396 z^-1 + 0.4665 z^-2

  F2(z) = 1 - 1.799 z^-1 + 0.8083 z^-2
```

```
Sample time: 14 seconds

Parameterization:
   Polynomial orders:   nb=[2 3]   nc=1   nd=1   nf=[2 2]   nk=[1 1]
   Number of free coefficients: 11
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using BJ on time domain data "ZT_2".
Fit to estimation data: 94.2% (prediction focus)
FPE: 3.658e-06, MSE: 3.418e-06

Model Properties
```

OE_model2

```
OE_model2 =
Discrete-time OE model: y(t) = [B(z)/F(z)]u(t) + e(t)
  B1(z) = 0.003623 z^-1

  B2(z) = 0.001766 z^-1

  F1(z) = 1 - 0.8903 z^-1

  F2(z) = 1 - 0.8563 z^-1

Sample time: 14 seconds

Parameterization:
   Polynomial orders:   nb=[1 1]   nf=[1 1]   nk=[1 1]
   Number of free coefficients: 4
   Use "polydata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using OE on time domain data "ZT_2".
Fit to estimation data: 71.51%
FPE: 8.459e-05, MSE: 8.259e-05

Model Properties
```

Non_linear_model2

```
Non_linear_model2 =

Nonlinear ARX model with 1 output and 2 inputs
  Inputs: u1, u2
  Outputs: y1

Regressors:
  Linear regressors in variables y1, u1, u2
  List of all regressors

Output function: Wavelet network with 3 units
Sample time: 14 seconds

Status:
Estimated using NLARX on time domain data "ZT_2".
Fit to estimation data: 94.73% (prediction focus)
FPE: 2.97e-06, MSE: 2.824e-06

Model Properties
```

Sunspace_model2

```
Sunspace_model2 =
  Discrete-time identified state-space model:
    x(t+Ts) = A x(t) + B u(t) + K e(t)
       y(t) = C x(t) + D u(t) + e(t)

  A =
              x1          x2          x3          x4
   x1      0.9239      0.1127    0.004036  -6.477e-05
   x2     -0.2531      0.5047   -0.003309     -0.4022
   x3   7.864e-06      0.1272     -0.8463      0.3838
   x4   -0.001261     0.04557      0.6172      0.5899

  B =
              u1          u2
   x1   0.0009058     0.00167
   x2     0.02331  -0.0002256
   x3    -0.01139    0.007945
   x4    0.001292   -0.001132

  C =
             x1         x2         x3         x4
   y1     0.6314    0.02662  0.0007636  -0.004911

  D =
       u1  u2
   y1   0   0

  K =
            y1
   x1   2.122
   x2   6.101
   x3  -3.144
   x4  -1.629

Sample time: 14 seconds

Parameterization:
   FREE form (all coefficients in A, B, C free).
   Feedthrough: none
   Disturbance component: estimate
   Number of free coefficients: 32
   Use "idssdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using N4SID on time domain data "ZT_2".
Fit to estimation data: 94.62% (prediction focus)
FPE: 3.194e-06, MSE: 2.949e-06

Model Properties
```