

Observer Design

System Matrices

```
A = [zeros(2,2),eye(2); -10, 10, -2, 2; 60, -660, 12, -12]
B = [0; 0; 1/300; -0.02]
C = [1,1,0,0]
```

```
A =
    0     0     1     0
    0     0     0     1
   -10    10    -2     2
    60  -660    12   -12
B =
     0
     0
  0.0033
 -0.0200
C =
     1     1     0     0
```

Observer Design (basic principles)

```
po=poly(A) % Open-loop characteristic polynomial
a=po(2:length(po) )
```

```
po =
  1.0e+003 *
    0.0010    0.0140    0.6700    1.2000    6.0000
a =
  1.0e+003 *
    0.0140    0.6700    1.2000    6.0000
```

```
Lob=[-15,-16,-18,-20]
pc=poly(Lob) % Desired closed-loop characteristic polynomial
ad=pc(2:length(pc))
```

```
Lob =
   -15   -16   -18   -20
pc =
     1     69    1778    20280    86400
ad =
     69    1778    20280    86400
```

```
Aof=[-a',[eye(3);0,0,0]] % State matrix for observer form
Cof=[1,0,0,0] % Input matrix for observer form
```

```
Aof =
  1.0e+003 *
   -0.0140    0.0010     0     0
   -0.6700     0    0.0010     0
   -1.2000     0     0    0.0010
   -6.0000     0     0     0
```

```

Cof =
    1     0     0     0

O=obsv(A,C)    % Observability matrix for the given realization.
Oof=obsv(Aof,Cof) % Observability matrix for the observer form.
T =O\Oof      % The transformation matrix.

```

```

O =
    1     1     0     0
    0     0     1     1
    50   -650    10   -10
   -700   6700   -90  -510

```

```

Oof =
1.0e+004 *
    0.0001     0     0     0
   -0.0014    0.0001     0     0
   -0.0474   -0.0014    0.0001     0
    1.4816   -0.0474   -0.0014    0.0001

```

```

T =
   -0.0100   -0.0054    0.0016   -0.0000
    1.0100    0.0054   -0.0016    0.0000
    2.1484   -0.0100   -0.0054    0.0016
   -16.1484    1.0100    0.0054   -0.0016

```

```

Lo=(ad-a)'    % Observer gain matrix for observer form
L=T*Lo        % Observer gain matrix for the given realization

```

```

Lo =
1.0e+004 *
    0.0055
    0.1108
    1.9080
    8.0400

```

```

L =
    20.0154
    34.9846
   130.8615
   207.1385

```

Using the MATLAB command place gives the same answer

```
place(A',C',Lob)'
```

```

place: ndigits= 15
ans =
    20.0154
    34.9846
   130.8615
   207.1385

```