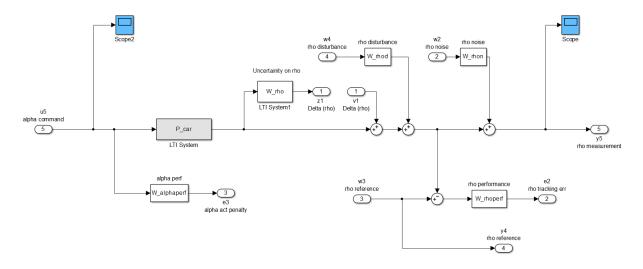
# **ATIC Exercise 10**

## a)

## i) model\_car:



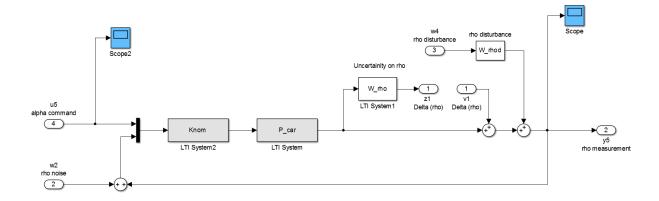
ii)

0.01

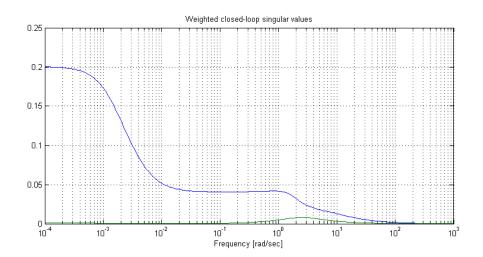
```
[A_P,B_P,C_P,D_P] = linmod('model_car');
P = ss(A_P, B_P, C_P, D_P);
P =
   a =
                                   x2
0
0
                                                   x3
1
0
0
0
0
0
0
                                                                                  x5
0
0
0
0
-4
0
                                                                                                                                x8
0
0
0
0
                   x1
                    0
                                                                 0
1
0
-20
0
0
0
                                                                                                  0
                     0
                              -59.38
    хЗ
               78.23
                                -400
0
                                                                                                   0
    x4
                    0
               40.74
                                                                                                                  0
    x5
x6
                                    0
                                                                                       -0.001667
                                                                                                                  0
                                                                                                                            -0.02
              -2.546
    x7
                                                                                                             -1000
    x8
   b =
                                      u3
                                                 u4
                                                            u5
               u1
                                           u4
0
0
0
0
0
0
0
0
0
                                                              0
                0
                            0
                                       0
    x1
    x2
                                       0
                                                              0
                            0
0
0
0
0
    x4
x5
x6
                 0
                                       0
           -0.25
                                   0.25
    x7
x8
                 0
                                       0
                                                           128
                           x2
0
                                      x3
0
                                                            x5
-2
0
                                                                                   x7
0
0
                                                 x4
0
0
                                                                       x6
0
                                                                                              0
0
           x1
20.37
    y1
y2
y3
y4
y5
                            0
                                       0
                                                                  0.1333
                                       0
                                                   0
                                                                         0
                                                                                -125
                                                                                                0
                 0
                            0
                                       0
                                                   0
                                                              0
                                                                         0
                                                                                    0
                                                                                                0
           10.19
                                       0
                                                                                            0.08
   d =
                                      u4
                                              u5
0
0
16
0
    y1
y2
y3
y4
y5
             0
                      0
                              0
0
0
1
                                       0
              0
                      0
                                       0 0
              0
                      0
```

```
[Knom, Gnom, gamma, info] = hinfsyn(Pnomdesign, nmeas, nctrl, ...
     'METHOD','ric',... % Riccati solution
     'DISPLAY','on',... % verbose
     'TOLGAM', 0.1);
                                  % gamma tolerance
Knom =
  a =
                          x2
                                      хЗ
                                                                         х6
  x1
           -18.69
                           0
                                                   0
                                                     -1.042e-08
                                                                          0
  x2
       -2.154e-15
                           0
                                       0
                                                      -1.201e-24
                                                                          0
           -87.04
                      -59.38
                                                      -9.215e-08
                                                                          0
                                   2.215
                                               -20.2
                                                                       534.6
   x4
           19.76
                      -405.8
                                                         -0.5922
         0.01322 36.23
                                                     -0.0005989
-1.086
  x5
                          0
                                      0
                                                  0
                                                                          0
                       -10.6
                                   4.061
                                             -0.3661
                                                                      -19.89
   x6
                                                     -0.0001203
            63.38
  x7
          -0.1468
  x1
x2
       -1.692e-17
-1.298
   хЗ
   x4
          0.01302
   х5
       0.0001038
   х6
         0.02388
   x7
           0.4958
  b =
              u1
                       20.78
   x1
               0
                   2.395e-15
   x2
               0
                       183.8
   хЗ
               0
                  -7.408e-15
  x4
               0
                      -2.847
            2.832
   x5
   x6
                      -70.49
   x7
               0
  c =
                   x2
-0.007314
                                x3 x4 x5
0.002801 -0.0002525 -0.0007488
              x1
  у1
          0.02499
       1.647e-05
   у1
  d =
       u1 u2
   у1
       0
           0
```

#### iv)



#### Gamma value achieved: 0.2143



c)

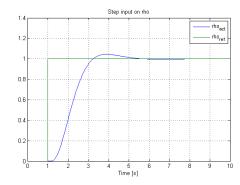
```
% Find closed loop eigenvalues
G_cl=lft(Pnomdesign,Knom,nctrl,nmeas);
eig(G_cl)
```

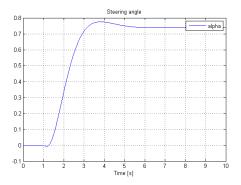
```
1.0e+03 *

-0.0000 + 0.0000i
-1.0000 + 0.0000i
-0.0089 + 0.0001i
-0.0089 - 0.0001i
-0.0088 + 0.0000i
-0.0012 + 0.0012i
-0.0012 - 0.0012i
-0.0005 + 0.0000i
-0.0100 + 0.0173i
-0.0100 + 0.0173i
-0.0100 + 0.0173i
-0.0100 - 0.0173i
-0.0100 - 0.0173i
-0.0100 - 0.0173i
-0.0100 - 0.0173i
```

They all have a negative real part > stable.

d)





Looking at the steering angle, we can nicely see the non-minimum phase behavior