Problem #2: *the model of a LTI dynamic system* S_2 *is given, fed by a suitable input signal* $u(t)$ *whose values have been saved in the* MATLAB **`data2a.mat`** *file. In all the simulations, assume* $x(1) = [-500, -10, 50]^T$ *as realization.*

HINT: put the command **`rng('default')`** at the beginning of the m-file **`es2.m`** to always generate the <u>same</u> random realizations.

2.1) *Design the steady-state Kalman predictor* $\mathcal{K}_\infty$ *in predictor-corrector form (i.e., not in standard form) and the dynamic Kalman filter* $\mathcal{F}_d$ *in standard form.*

Write the numerical values of:

- the steady-state gain matrix
- the dynamic predictor and filter gain matrices (final values)

Numerical value of the steady-state gain matrix:

```
K0bar =

   -1.8948
   -0.0282
    0.2367
```

Numerical values of the dynamic predictor and filter gain matrices (final values):

```
K =

   -2.3667
   -0.0379
    0.2811

K0 =

   -1.8948
   -0.0282
    0.2367
```

2.2) *Compare the state and output estimates provided by* $\mathcal{K}_\infty$ *and* $\mathcal{F}_d$ *by means of plots and evaluate the* $RMSE_{xk}$ *for* k = 1,…,3 and the $RMSE_y$*, explaining the different results obtained for* N'_0 = 0, 10, 100.

2.2.a) Write the numerical values of $RMSE_{xk}$ and $RMSE_y$ for N'_0 = 0, 10, 100:

```
Numerical values of RMSEx and RMSEy for N'0 = 0:

RMSE_xh_ss_pc =

19.3455
0.4013
1.8621

RMSE_xf =

17.9133
0.3776
1.6989

RMSE_yh_ss_pc =

0.1037

RMSE_yf =

0.0296

Numerical values of RMSEx and RMSEy for N'0 = 10:

RMSE_xh_ss_pc =

11.6780
0.2483
1.0952

RMSE_xf =

10.5556
0.2235
0.9951

RMSE_yh_ss_pc =

0.0427

RMSE_yf =

0.0293

Numerical values of RMSEx and RMSEy for N'0 = 100:
```

```
RMSE_xh_ss_pc =

0.2616
0.0052
0.0265

RMSE_xf =

0.2567
0.0051
0.0258

RMSE_yh_ss_pc =

0.0211

RMSE_yf =

0.0186
```

2.2.b) Clear report including the reasoning behind the computations and the possible critical analysis of the main numerical results:

In order to evaluate the gain matrix of the steady state Kalman predictor (K0bar), I used the command "Kalman", instead in order to evaluate the matrix of the dynamic Kalman filter (K0,K) I used a loop.
From the results obtained from the RMSE evaluations, we can notice that, in general, as the number of samples to neglect at the transient increase, our results get better (decrease).
In particular the results shows that the filtered system is better than the predicted one, that is because the filtered system uses also the information coming, from the last value of y(N).