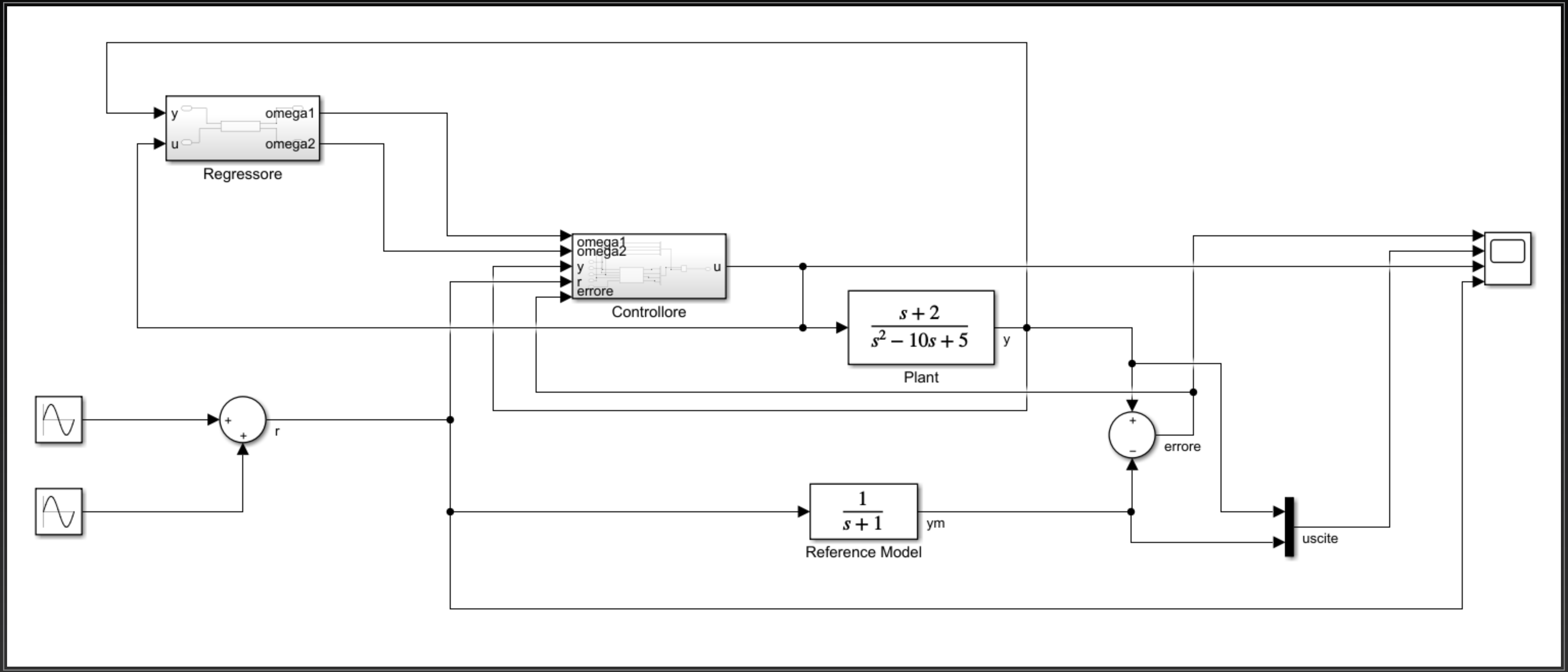
Assignment 5

Controllo robusto e adattativo

Coccia Gianluca 0300085, Lomazzo Alessandro 0294640

Modello Simulink



Istruzioni per l'esecuzione

Definizione dei parametri di simulazione tramite script Matlab.

I parametri E_1, E_2, $freq_1$, $freq_2$ possono essere cambiati per variare il riferimento in ingresso r.

La matrice Γ può essere variata ma deve essere definita positiva.

Assignment5Mat.m

```
% Definizione parametri assignment 5
% Gianluca Coccia 0300085, Alessandro Lomazzo 0294640
% 17/12/2020

clearvars
close all
clc

% Parametri r
E1 = 2;
E2 = 5;
freq1 = 5;
freq2 = 1;

% Parametrizzazione
lambda = 2; %poichè Lambda(s)=s+2
gammaMat = [50 0 0 0
            0 50 0 0
            0 0 50 0
            0 0 0 50];
```

Verifica di soddisfazione delle ipotesi

1 Plant assumptions

- $Z(s)$ is a monic Hurwitz polynomial of degree m. Yes, $\forall b_0 > 0$.
- An upper bound N of the degree n of $R(s)$ is known. Yes, 2.
- The relative degree of the system, that is $\mathrm{rd} = n - m$, is known. Yes, $\mathrm{rd} = 2 - 1 = 1$.
- The sign of the high frequency gain k is known(assume it is positive). Yes, $\forall k > 0$.

2 Reference model assumptions

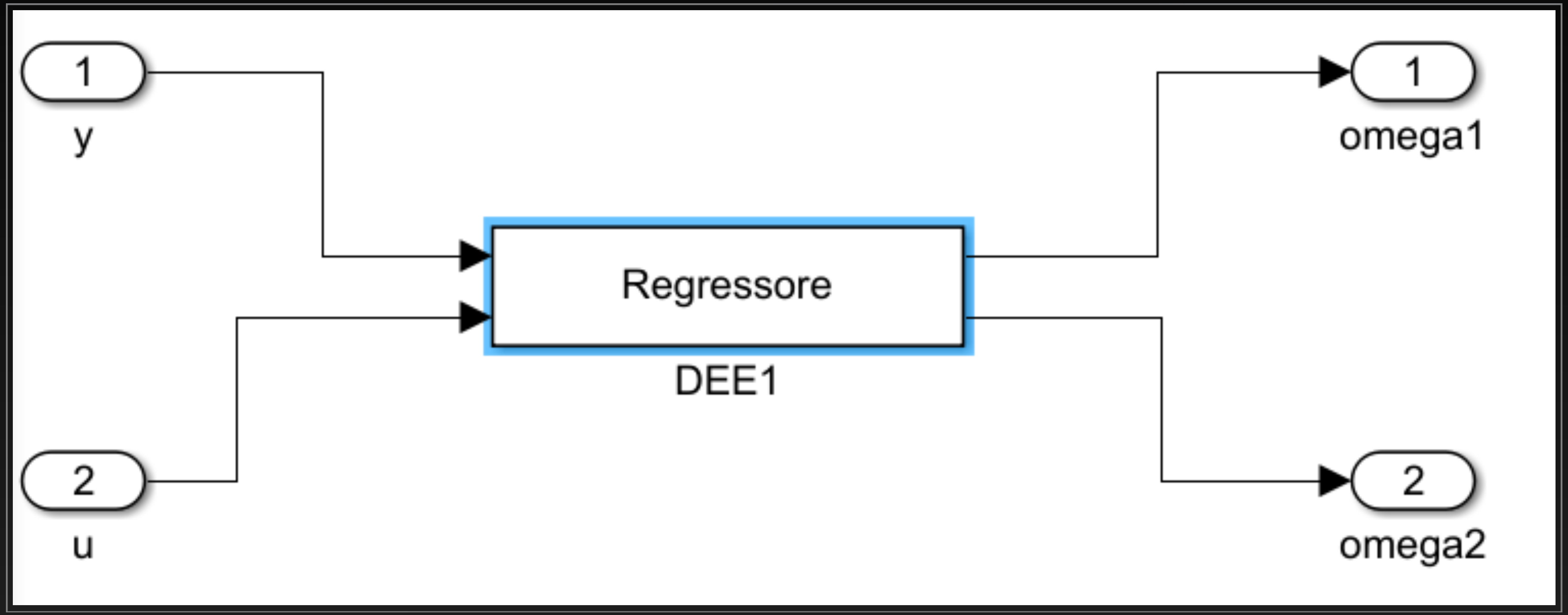
- $Z_m(s)$ and $R(s)$ are monic Hurwitz polynomial of degree m_m and n_m, respectively and $n_m \le N$.

  Yes, $m_m = 0$ and $n_m = 1$ also $n_m = 1 \le N = 2$.
- The relative degree of the model, that is $\mathrm{rd}_m = n_m - m_m$, is such that $\mathrm{rd}_m = \mathrm{rd}$.

  Yes $\mathrm{rd}_m = 1 = \mathrm{rd}$.

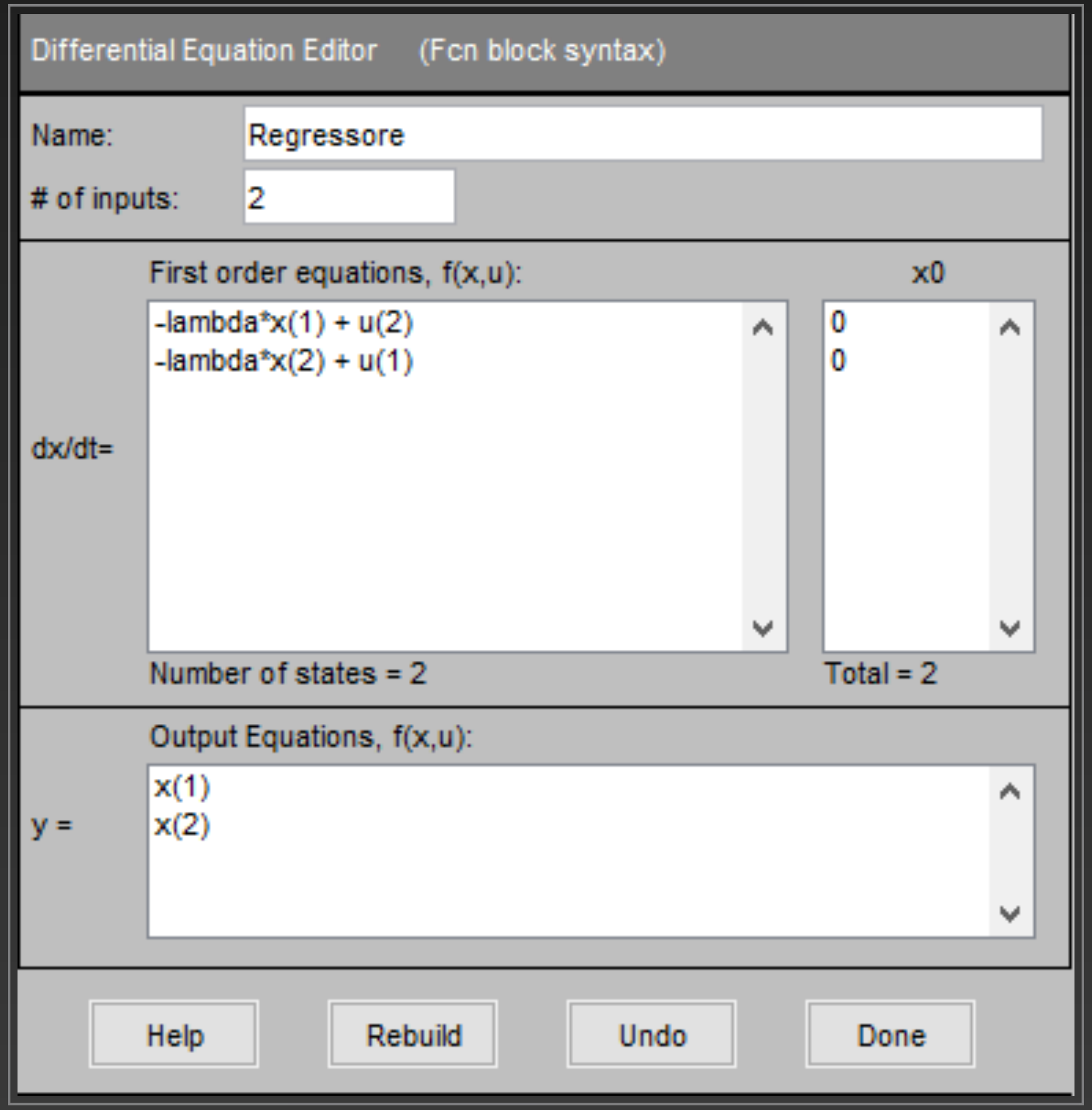
Tutte le ipotesi sono soddisfatte

Modelli Teorici

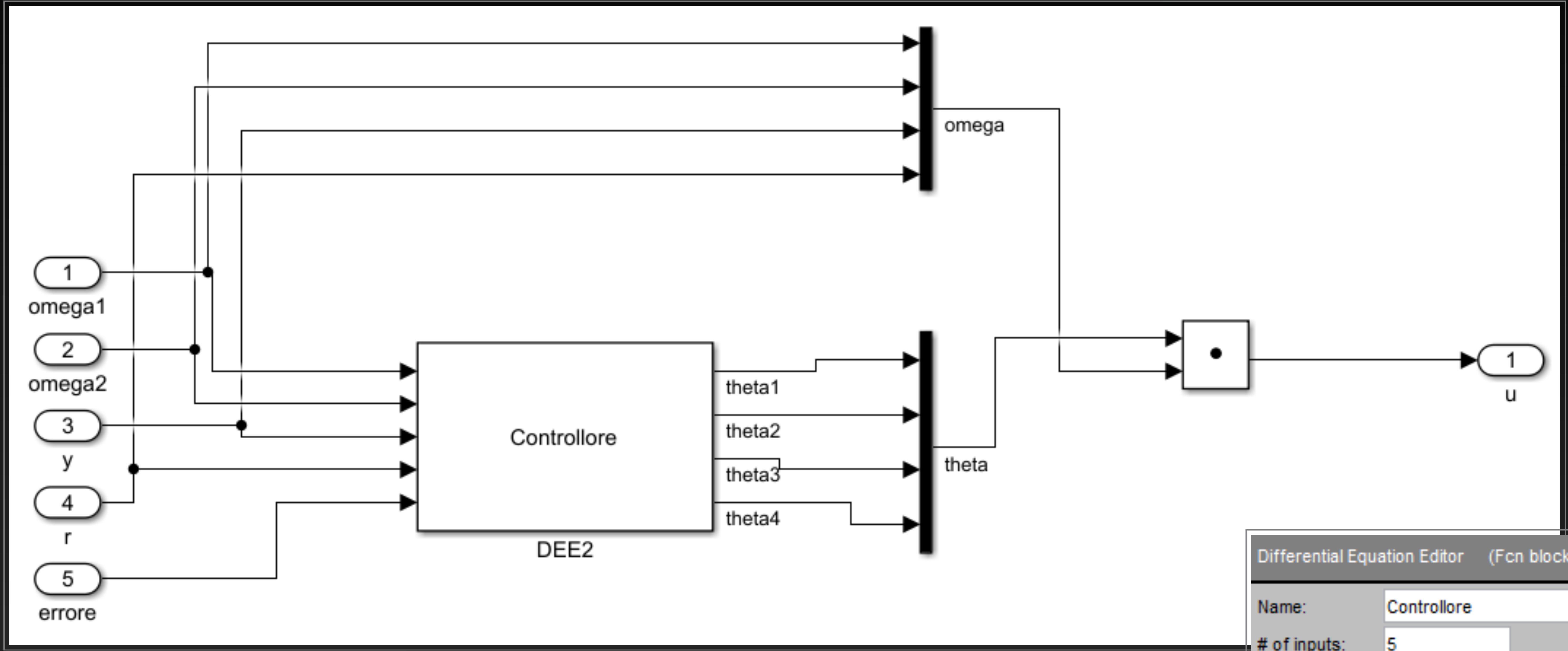


$$\dot{\omega}_1 = F\omega_1 + gu$$

$$\dot{\omega}_2 = F\omega_2 + gy$$

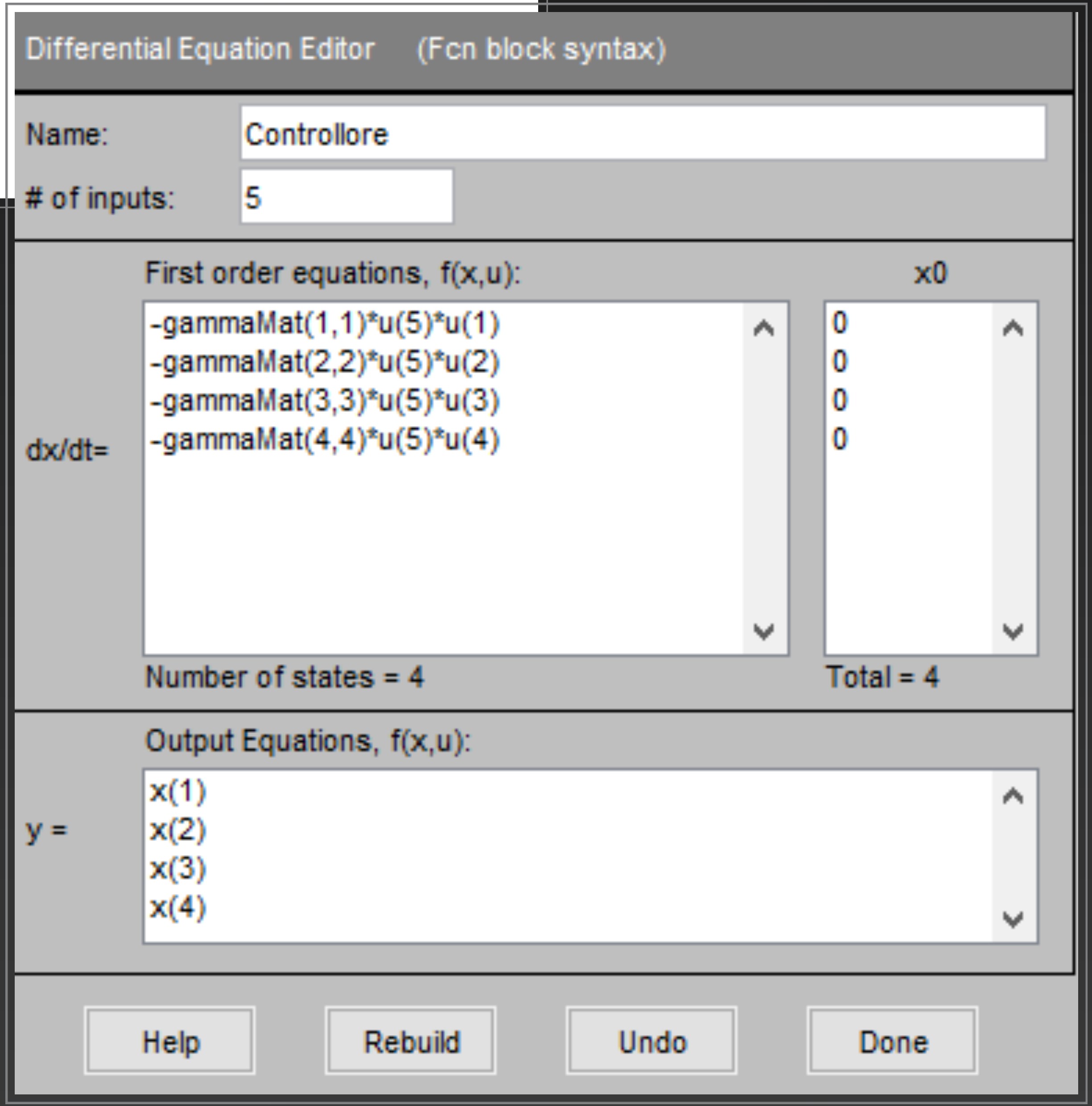


Modelli Teorici

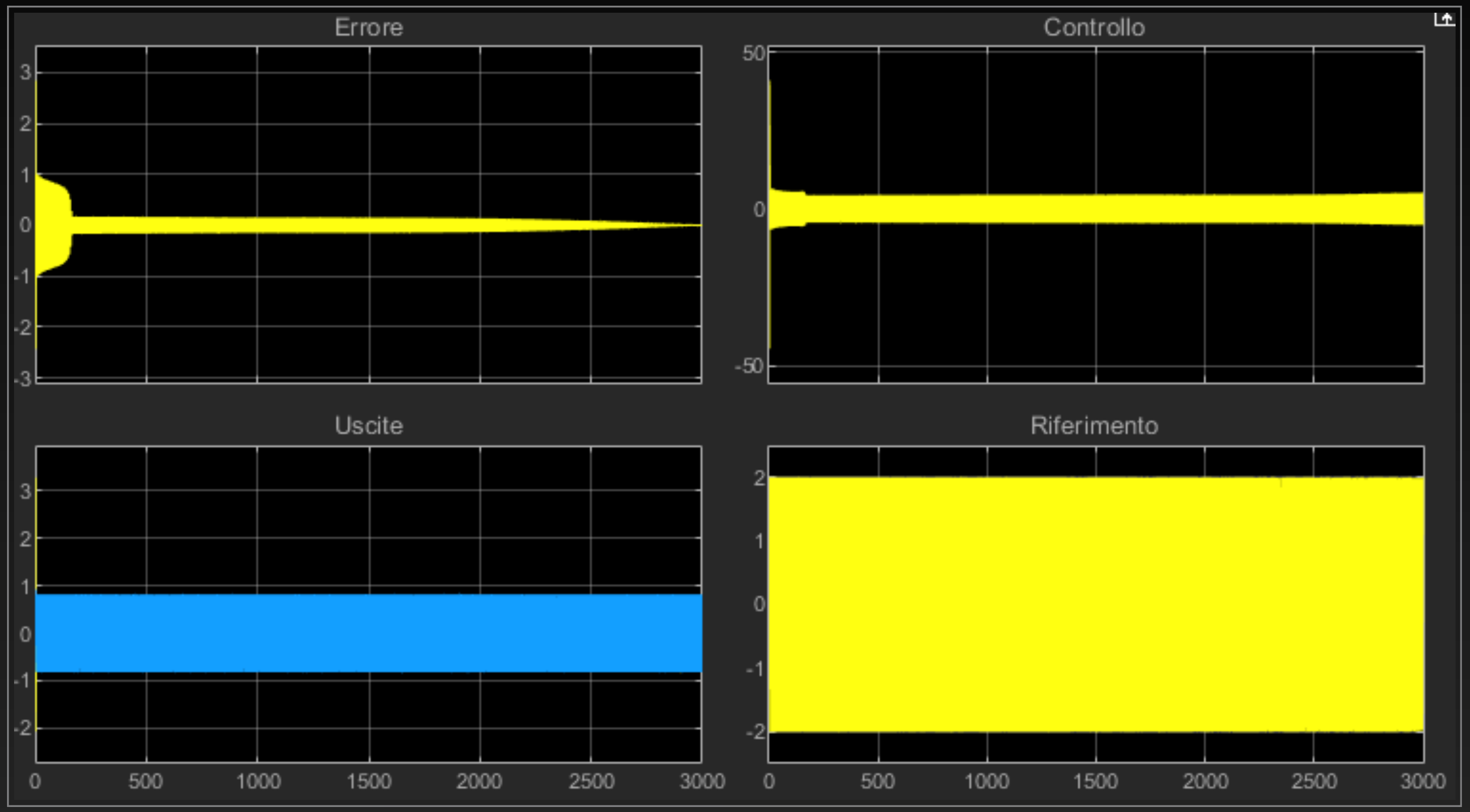


$$\theta = \begin{bmatrix} \theta_1^\top & \theta_2^\top & \theta_3 & c \end{bmatrix}^\top, \ \omega = \begin{bmatrix} \omega_1^\top & \omega_2^\top & y & r \end{bmatrix}^\top$$

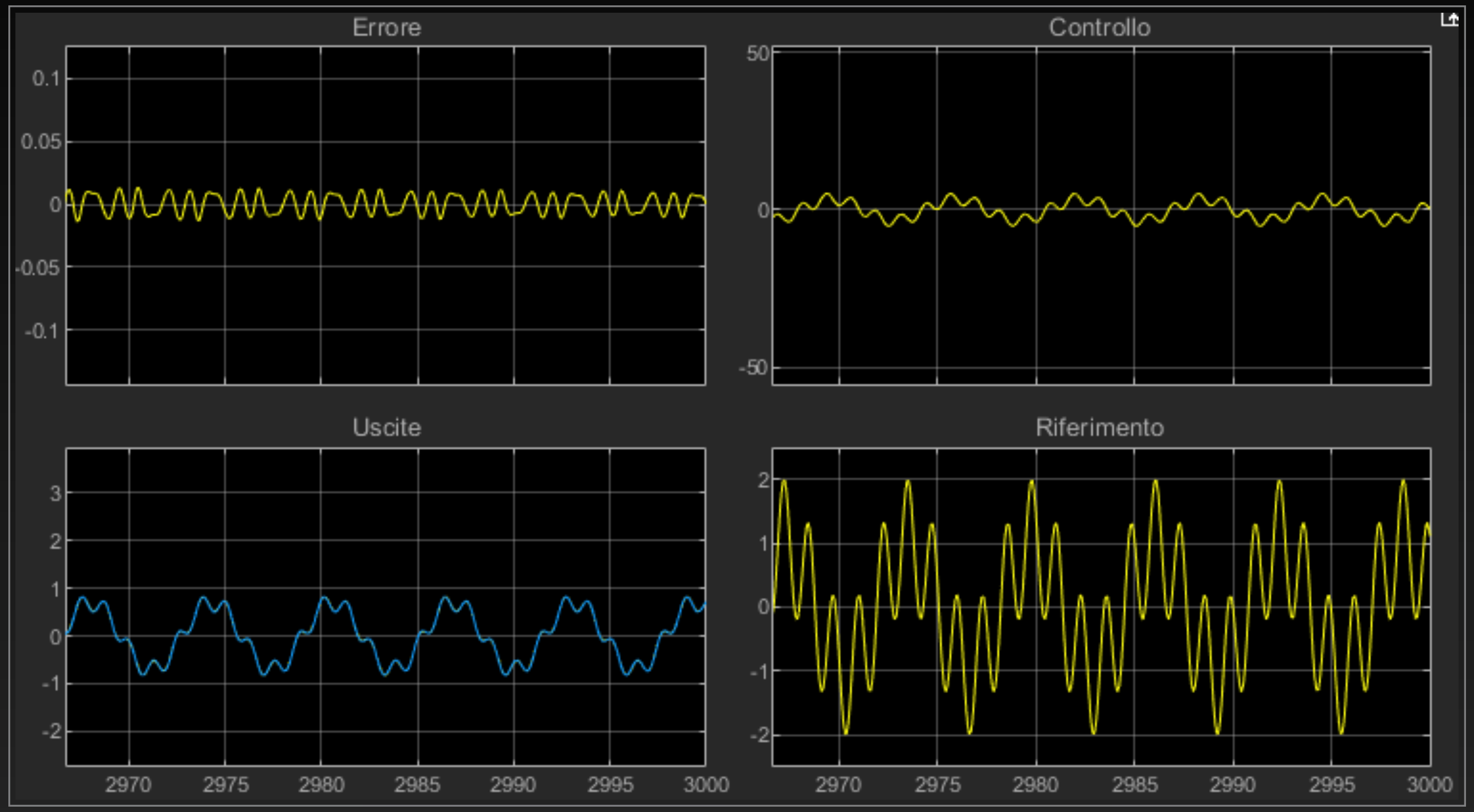
$$u = \hat{\theta}^\top \omega$$



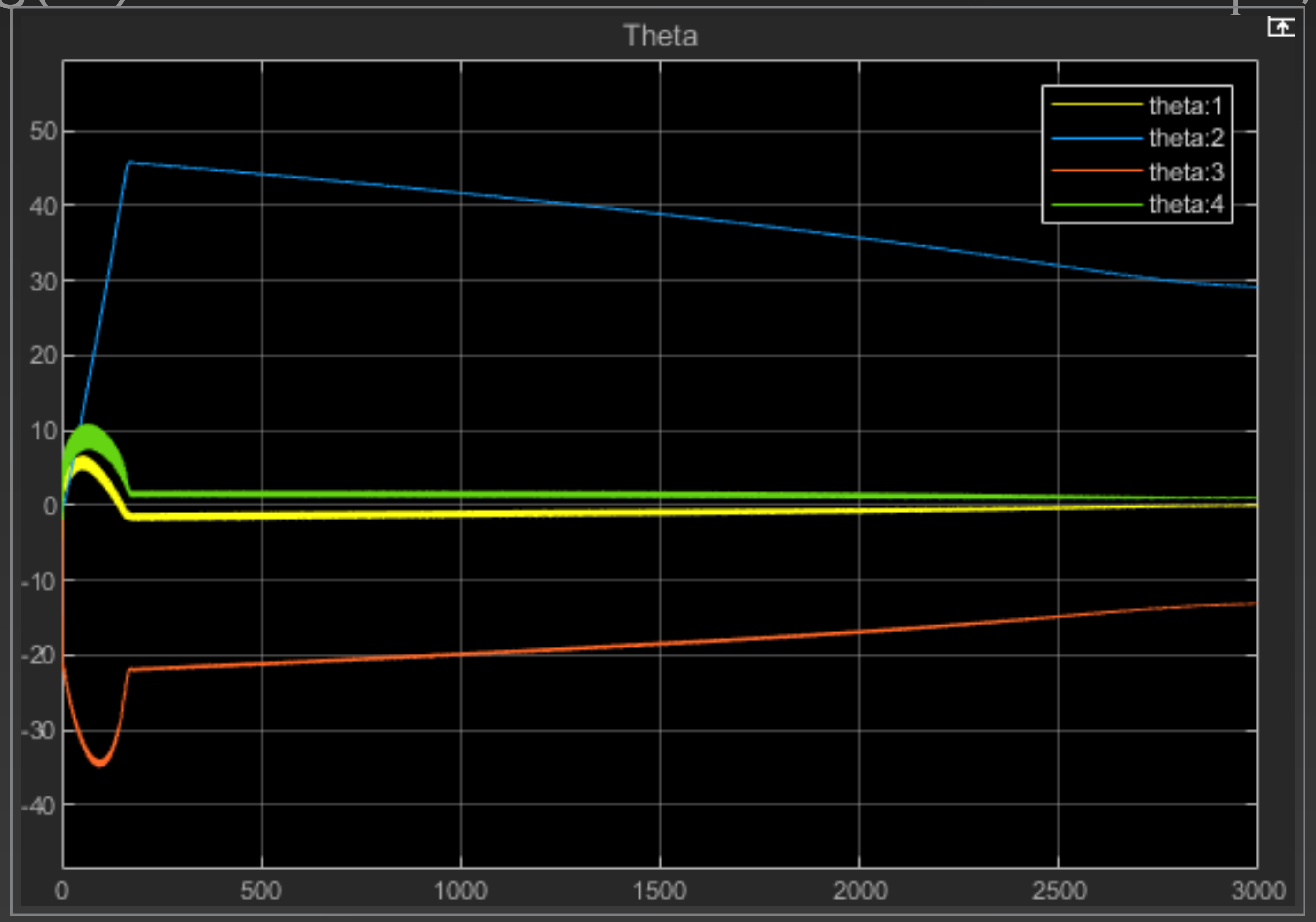
Simulazioni



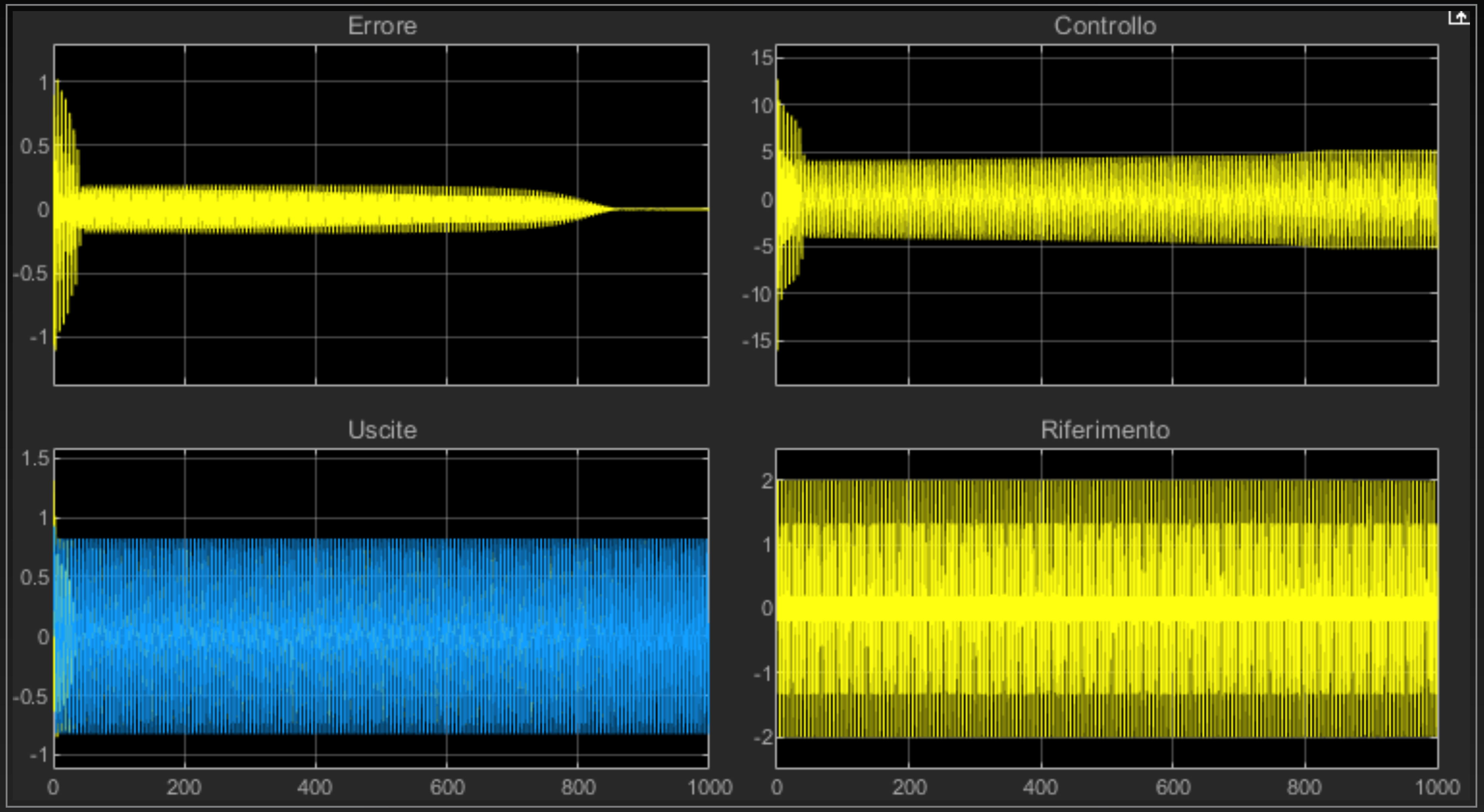
E_1=1, E_2 = 1, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(10)



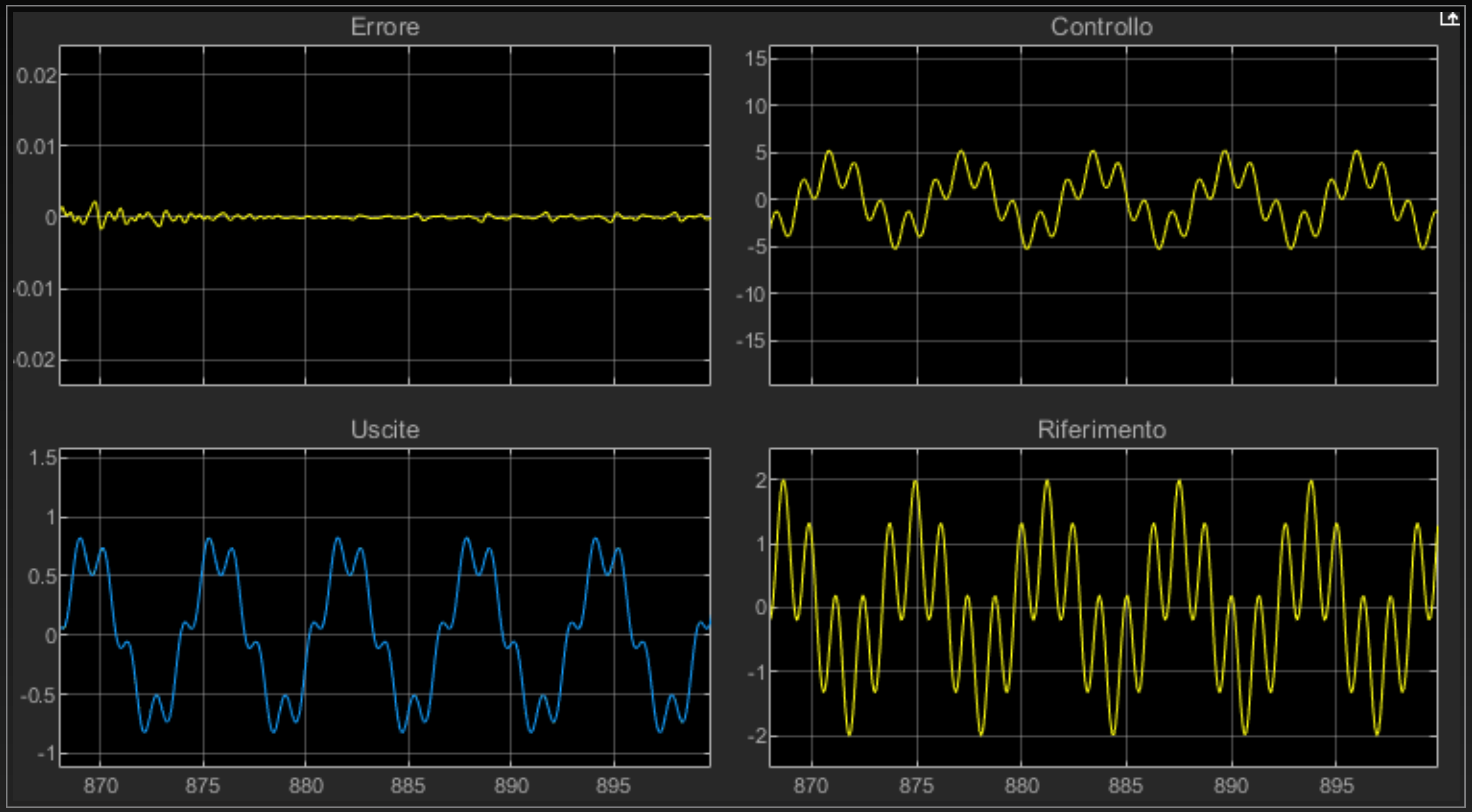
E_1=1, E_2 = 1, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(10)



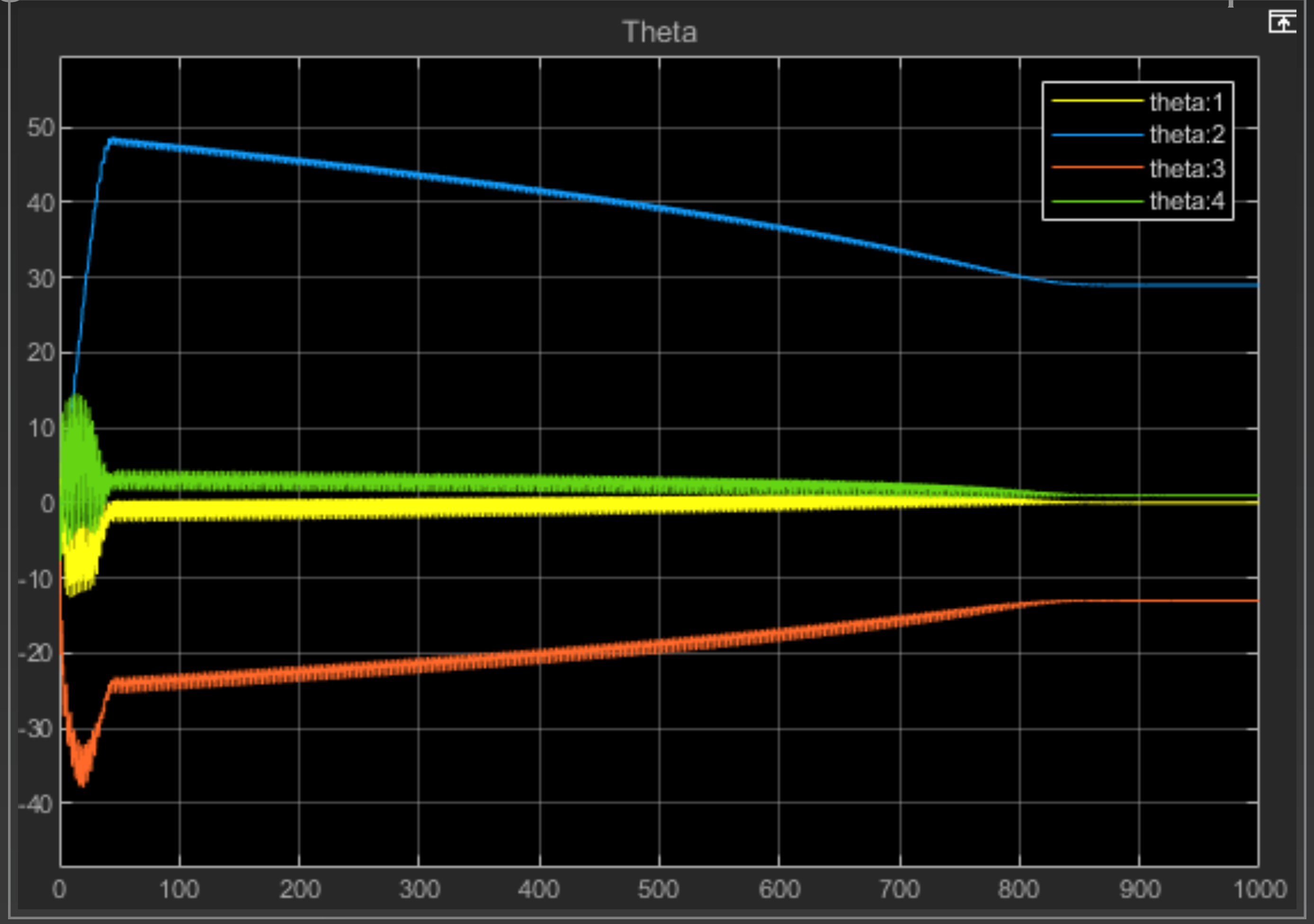
Simulazioni



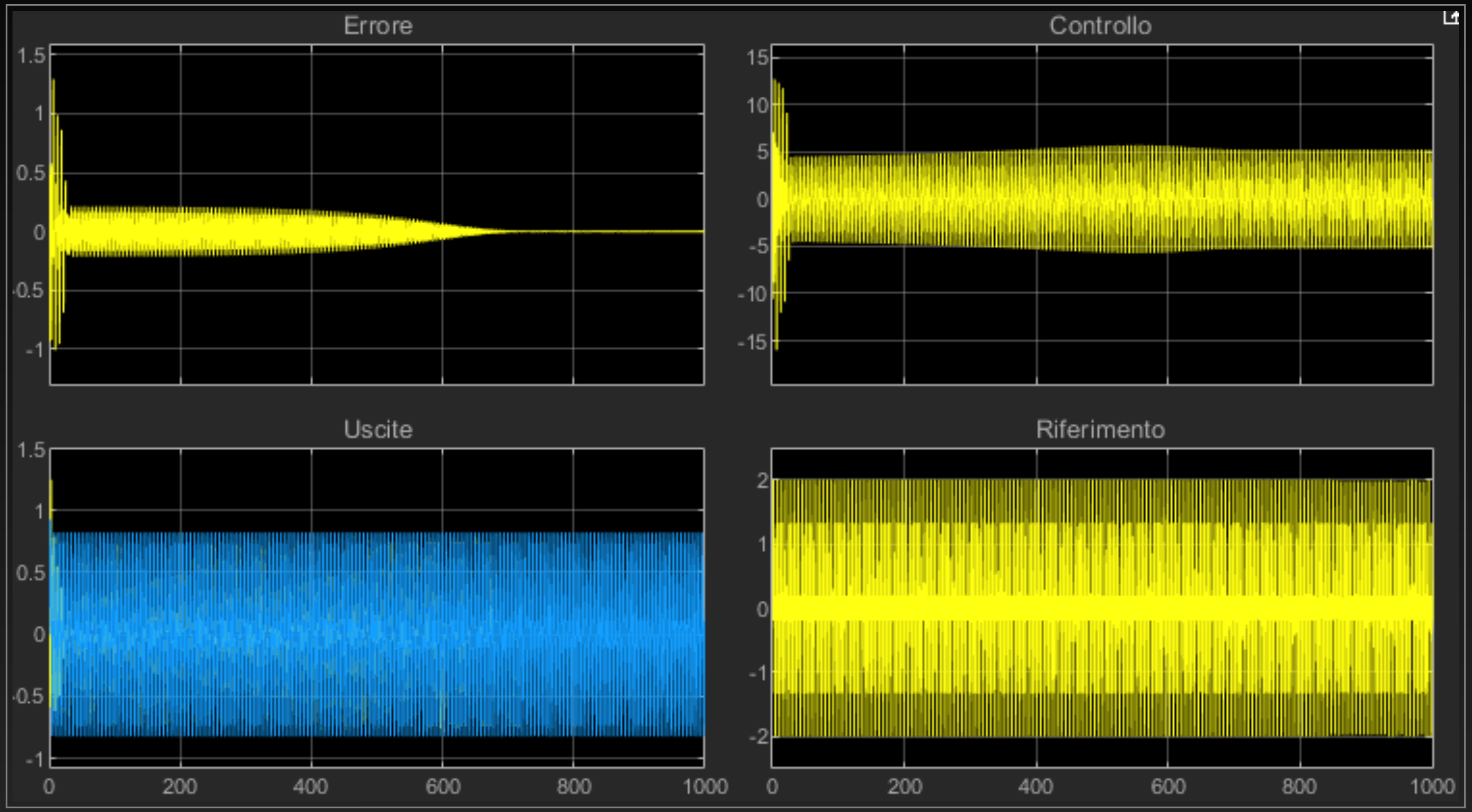
E_1=1, E_2 = 1, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(50)

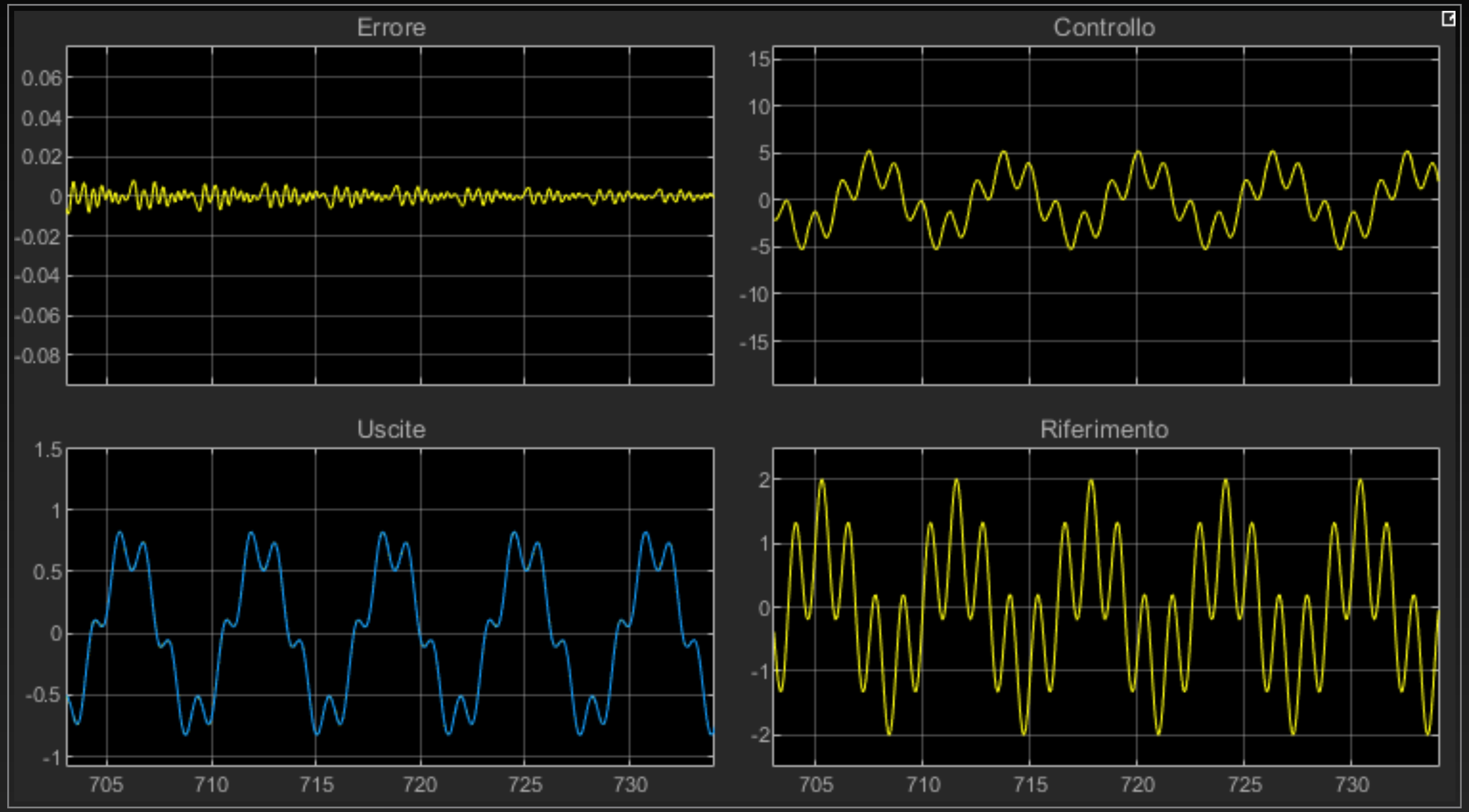


E_1=1, E_2 = 1, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(50)



Simulazioni





E_1=1, E_2 = 1, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(90)

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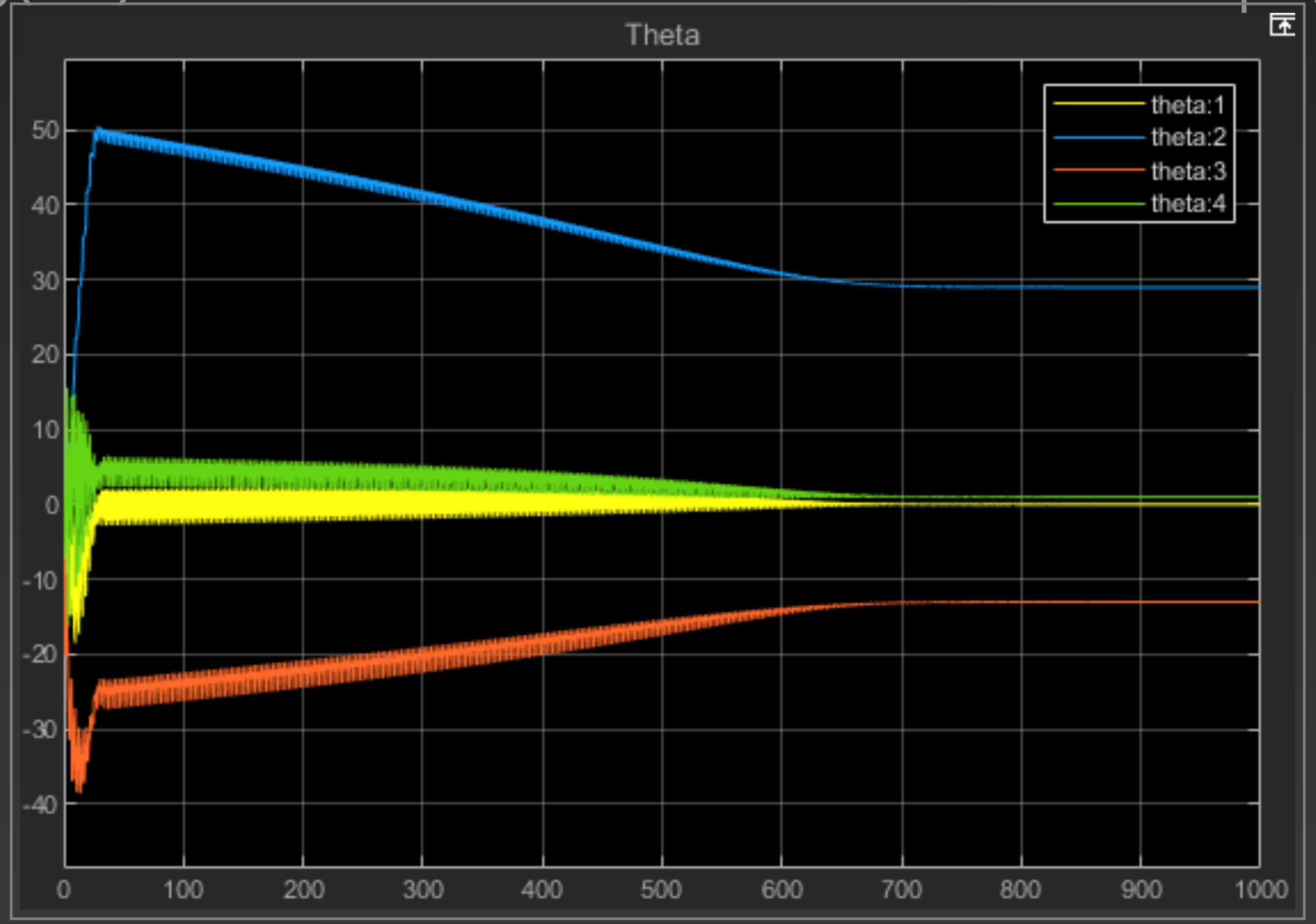
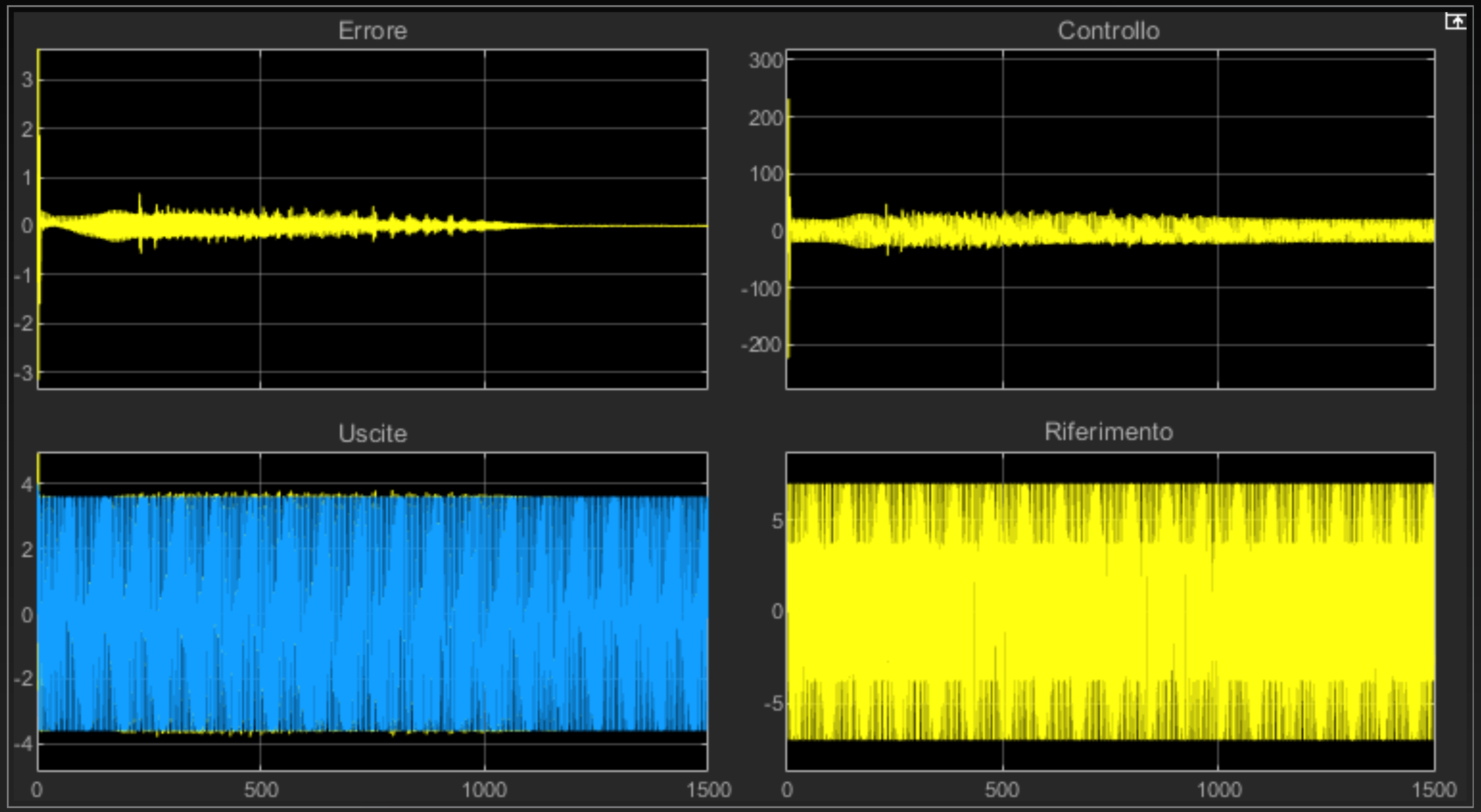
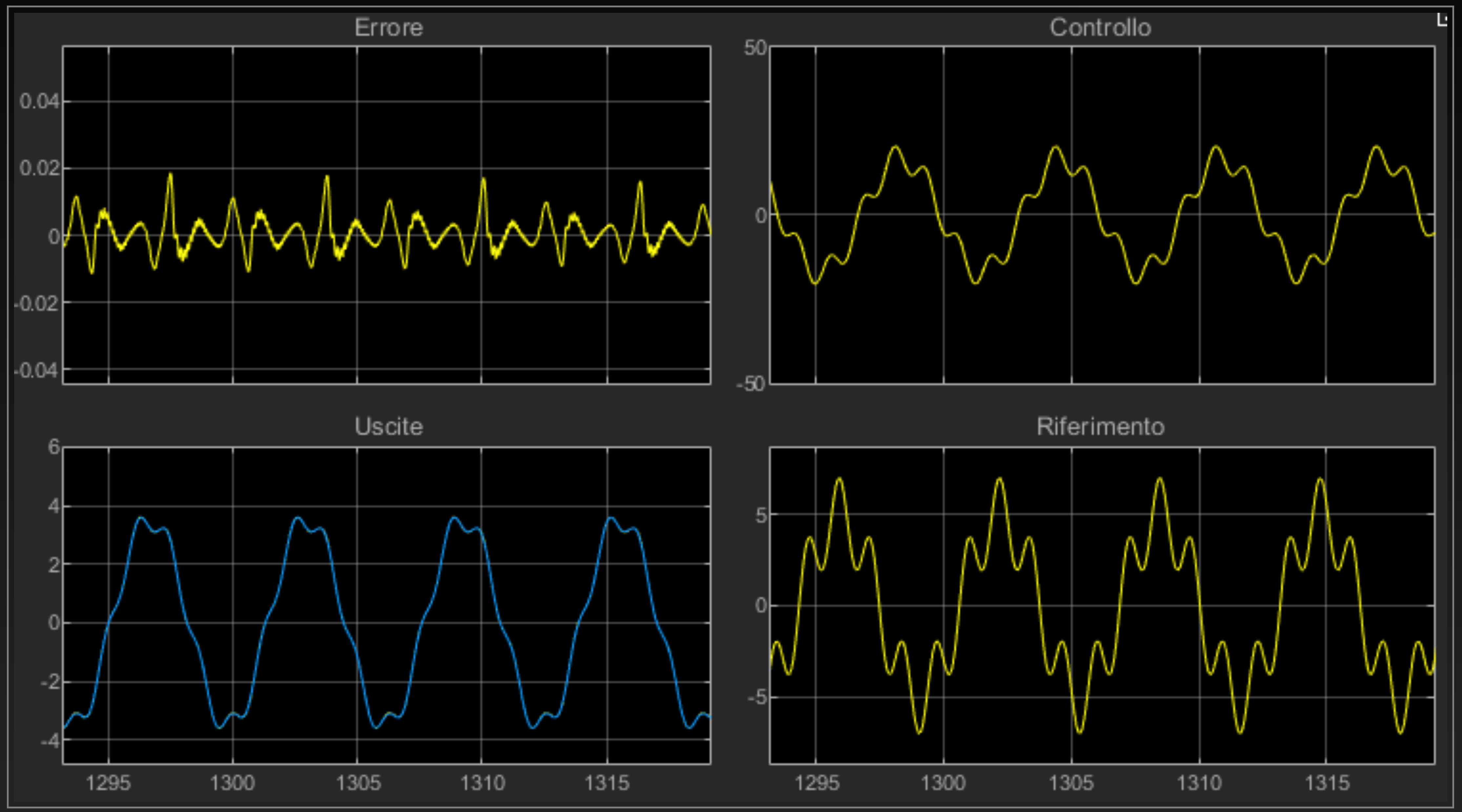


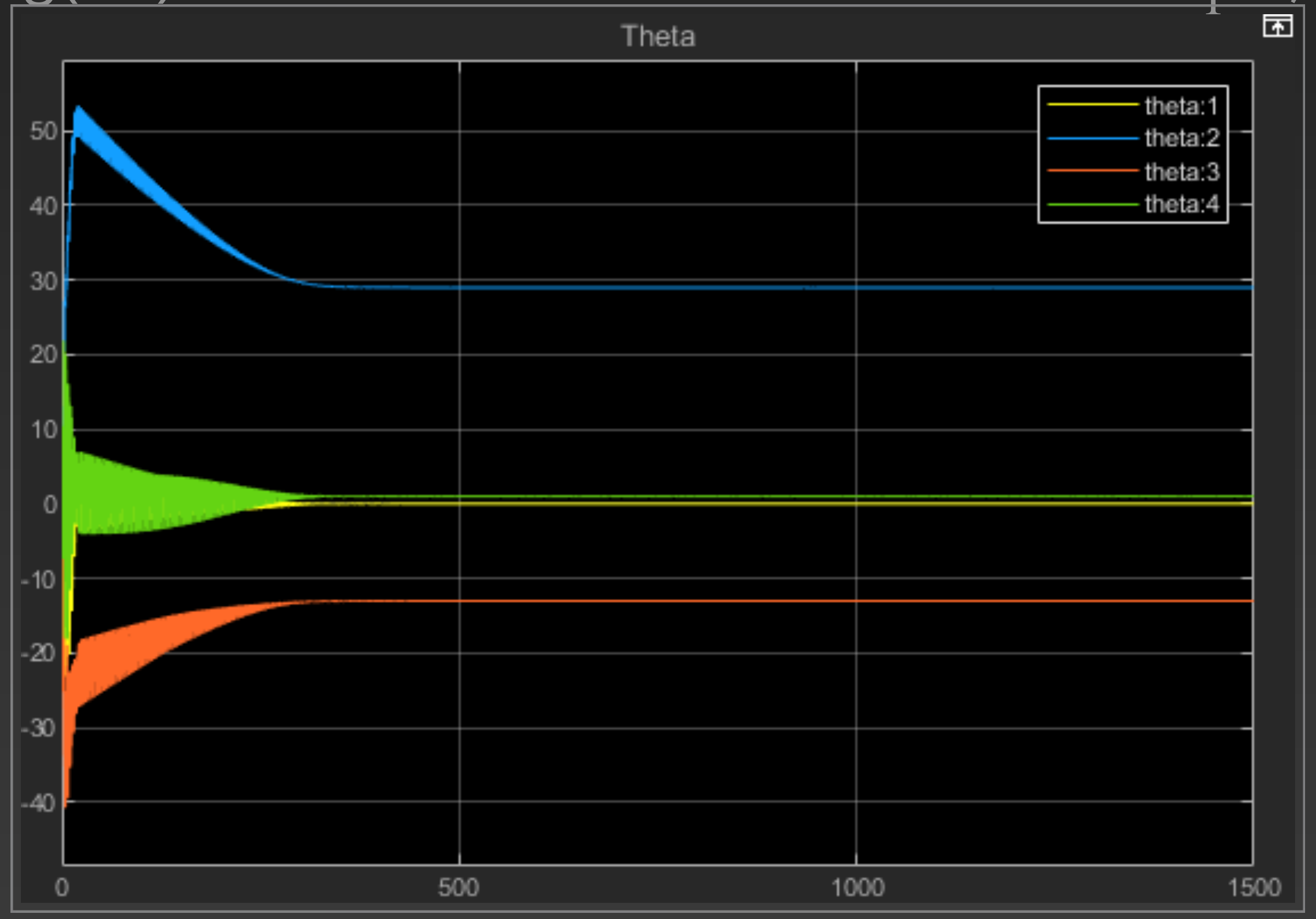
Simulazioni



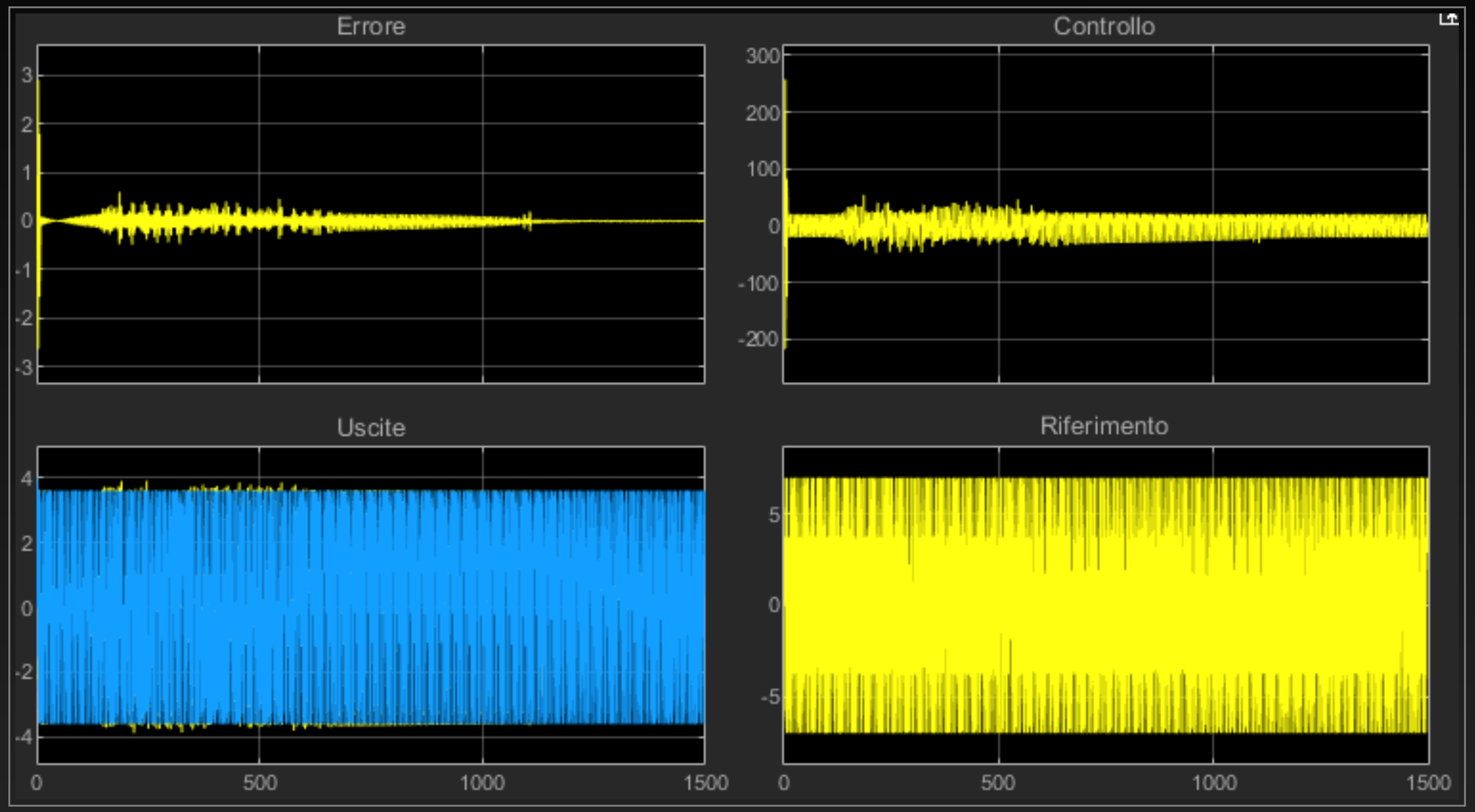
E_1=5, E_2 = 2, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(50)



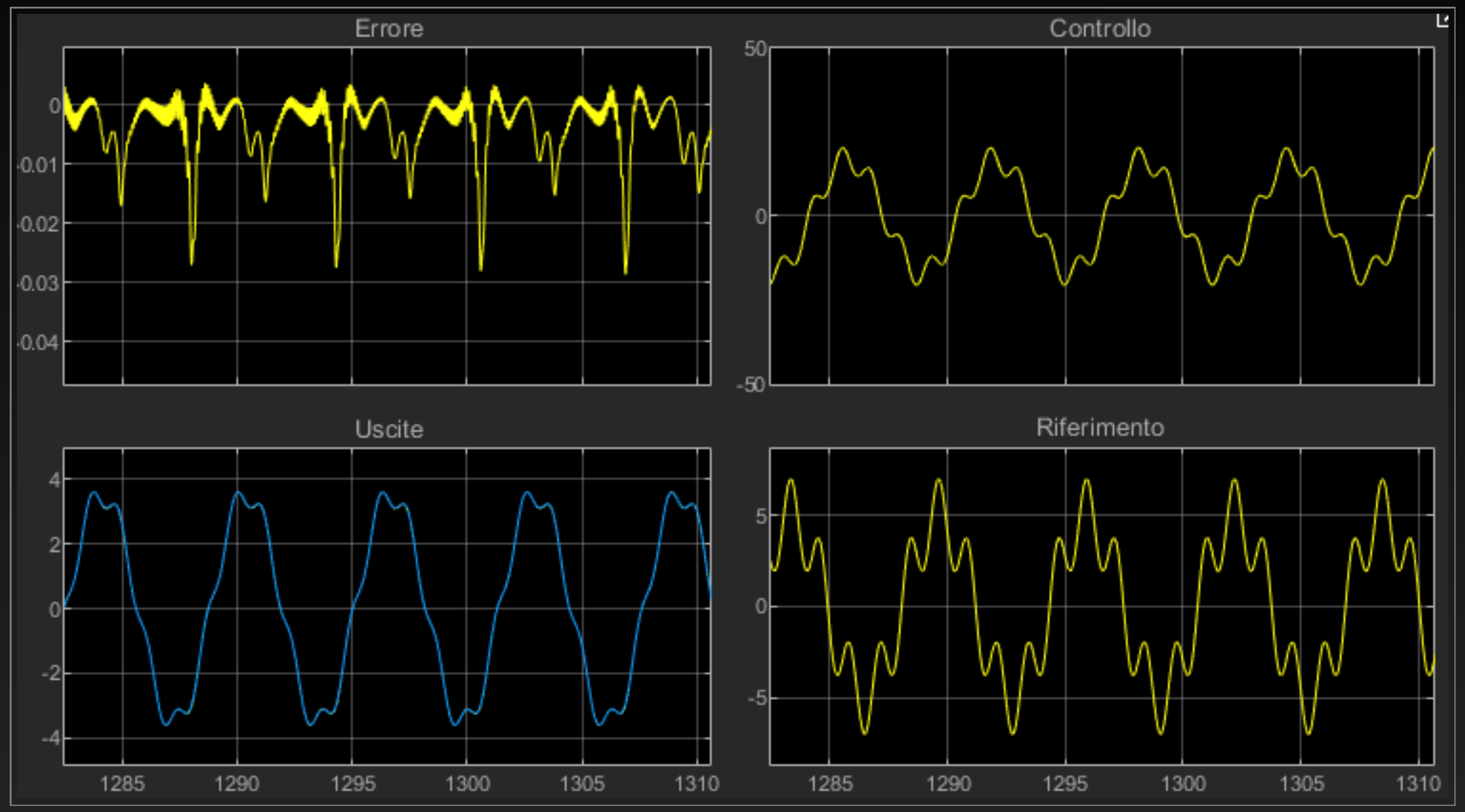
E_1=5, E_2 = 2, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(50)



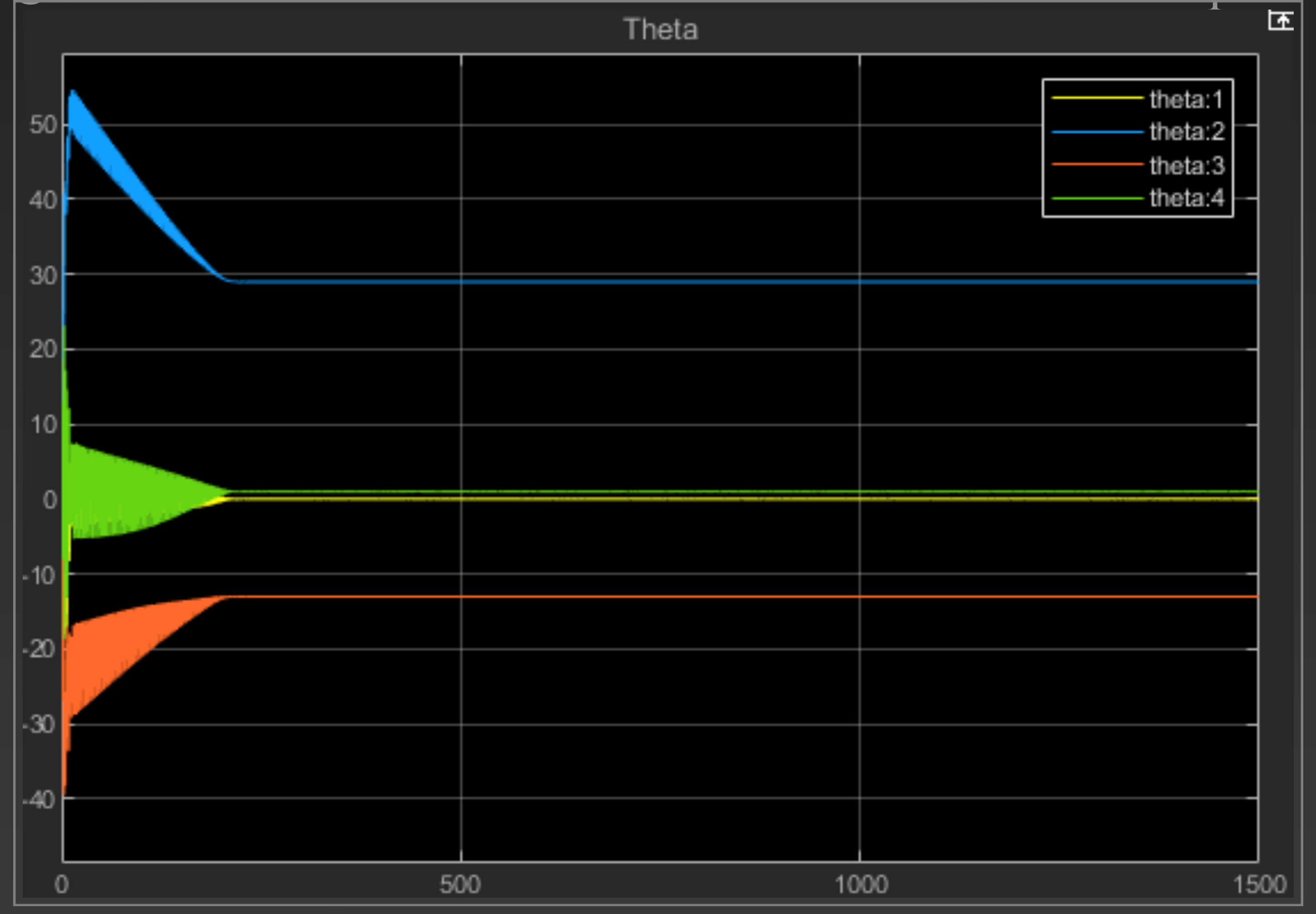
Simulazioni



E_1=5, E_2 = 2, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(90)



E_1=5, E_2 = 2, $freq_1$ = 5, $freq_2$ = 1, Γ = diag(90)



Conclusioni

L'errore in ogni caso tende asintoticamente a 0, come ci aspettiamo dalla teoria dato che le ipotesi del MRAC sono soddisfatte, con questi ingressi in particolare ci mette molto tempo: circa 1000 secondi in media. Il risultato varia in base alle frequenze e ampiezze delle sinusoidi in ingresso e in base alla matrice Γ. Infatti a valori bassi della matrice Γ corrisponde un transitorio più regolare con tempi di risposta maggiori, con stime dei parametri lente, mentre a valori alti corrisponde un transitorio meno regolare con tempi di risposta minori, azioni di controllo più intense e stime dei parametri veloci.