In this section, an academic example for which neither KKLO nor PEBO is applicable, but it is solvable via our new [KKL+PEB]O design.

Proposition 6: Consider the system

$$\begin{aligned}
\dot{x}_1 &= -x_1^3 + e^{x_3} \\
\dot{x}_2 &= -x_2 + x_1^2 + \sin x_1 \\
\dot{x}_3 &= (x_1^2 + 1)^{-1} + x_1 u \\
y &= x_1 .
\end{aligned} \tag{31}$$

The following facts hold.

F3 The system *does not admit* a KKLO nor a PEBO.

F4 The system *admits* a [KKL+PEB]O, namely

$$\dot{\xi}_1 = -\xi_1 + y^2 + \sin y \tag{32}$$

$$\dot{\xi}_2 = uy + (y^2 + 1)^{-1} \tag{33}$$

$$\dot{\hat{\Theta}} = \gamma\psi(Y - \psi\hat{\Theta}) \tag{34}$$

$$\hat{x}_2 = \xi_1 \tag{35}$$

$$\hat{x}_3 = \xi_2 + \ln \hat{\Theta}, \tag{36}$$

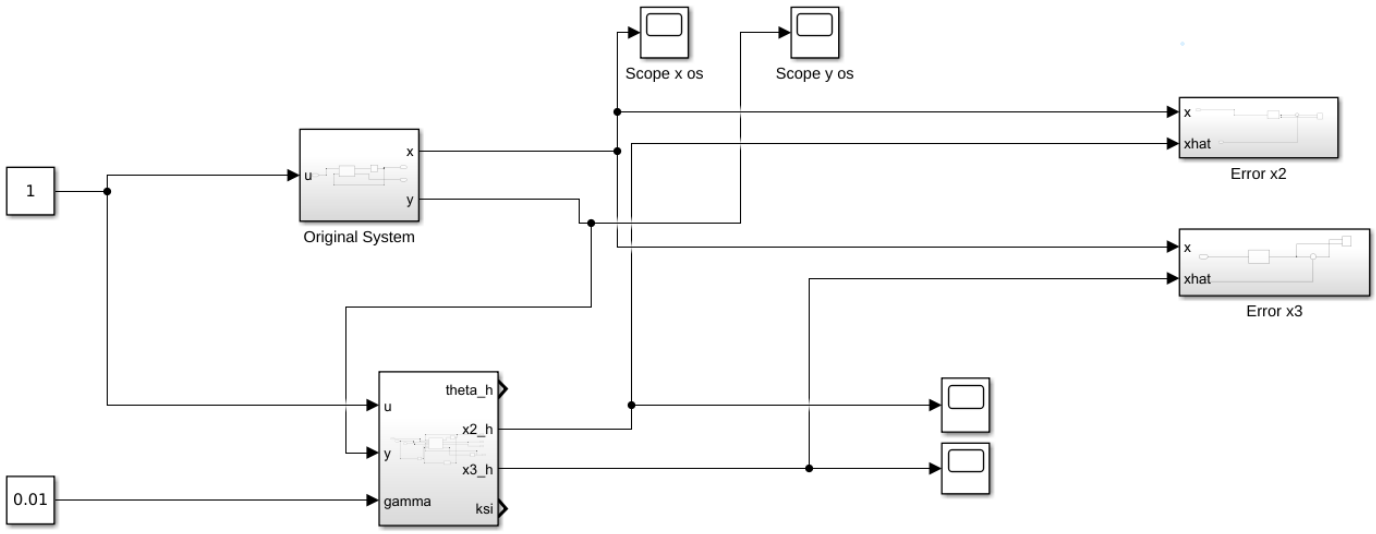
where $\gamma > 0$ is an adaptation gain, and Y and ψ are obtained via LTI filtering as

$$\begin{aligned}
Y &= \frac{\alpha p}{p+\alpha}[y] + \frac{\alpha}{p+\alpha}[y^3] \\
\psi &= \frac{\alpha}{p+\alpha}[e^{\xi_2}], \; \psi(0) > 0
\end{aligned} \tag{37}$$

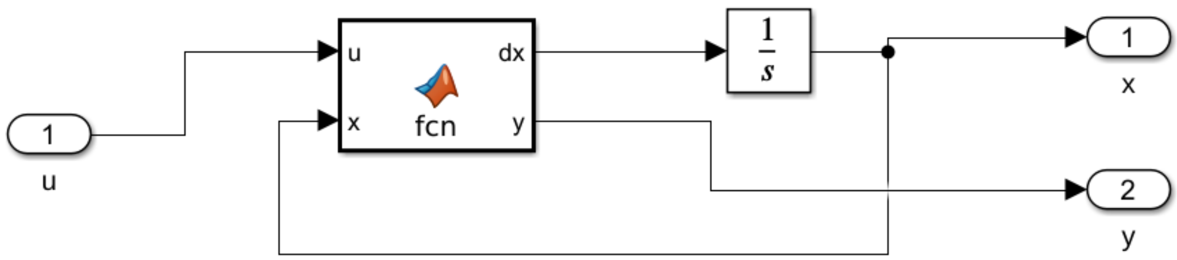
with $p := \frac{d}{dt}$, and $\alpha > 0$ is a [KKL+PEB]O that ensures

$$\lim_{t\to\infty} |\hat{x}_i(t) - x_i(t)| = 0, \; i = 2, 3.$$

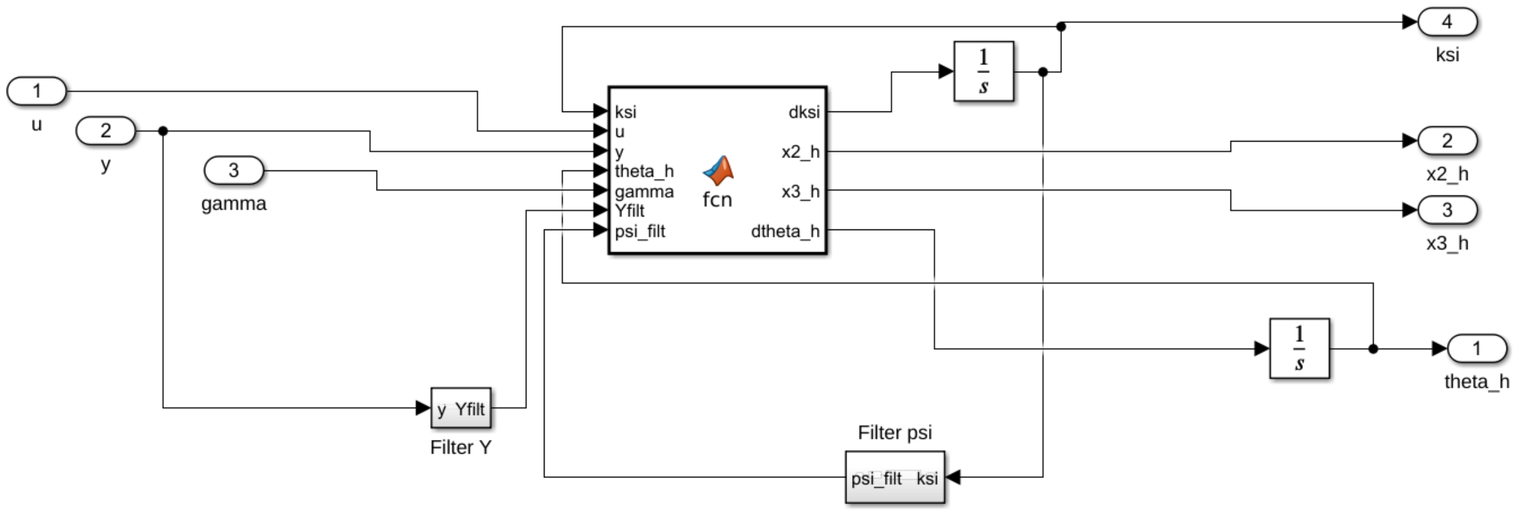
Модель Simulink:



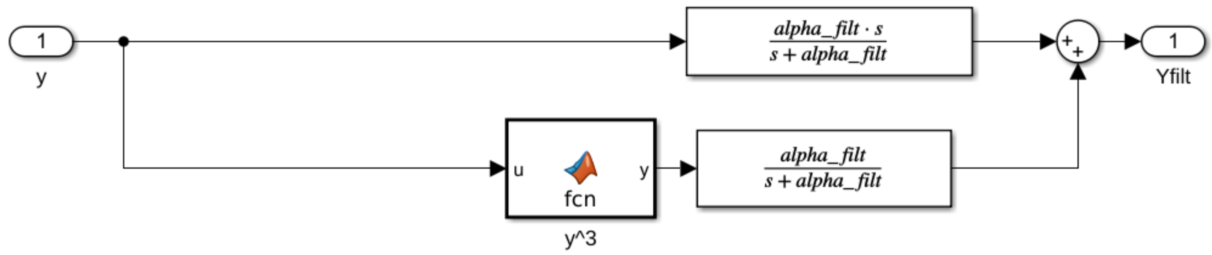
Оригинальная модель:

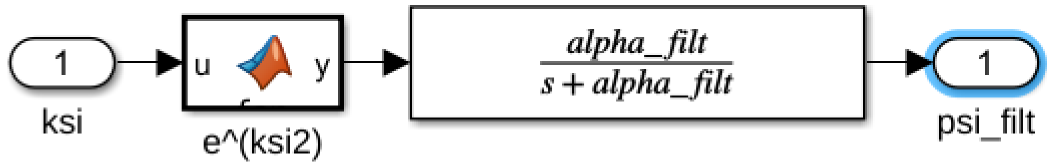


Наблюдатель:

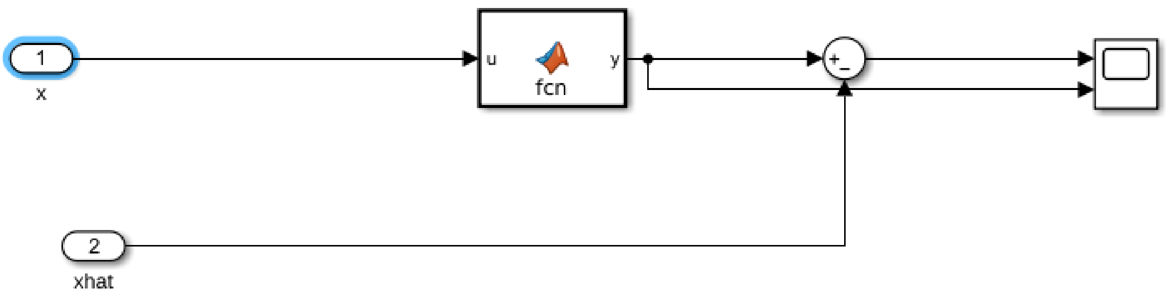


Подмодели:

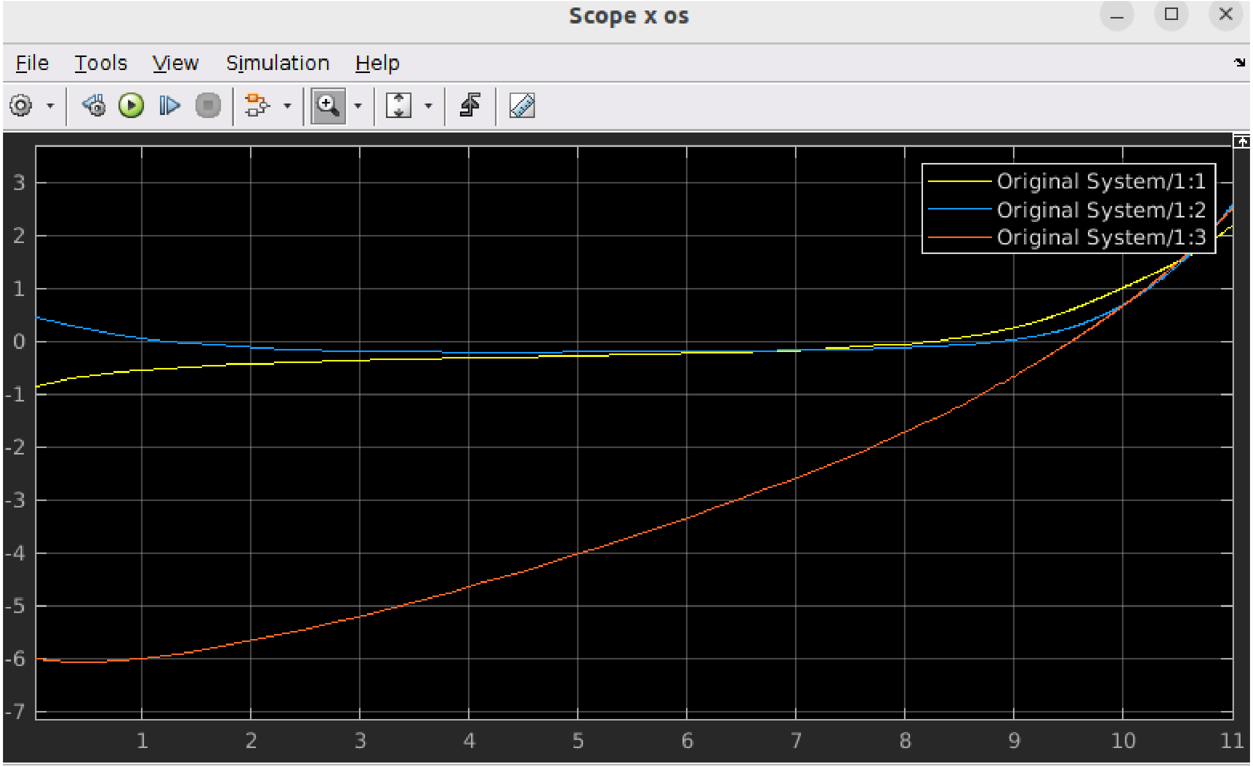




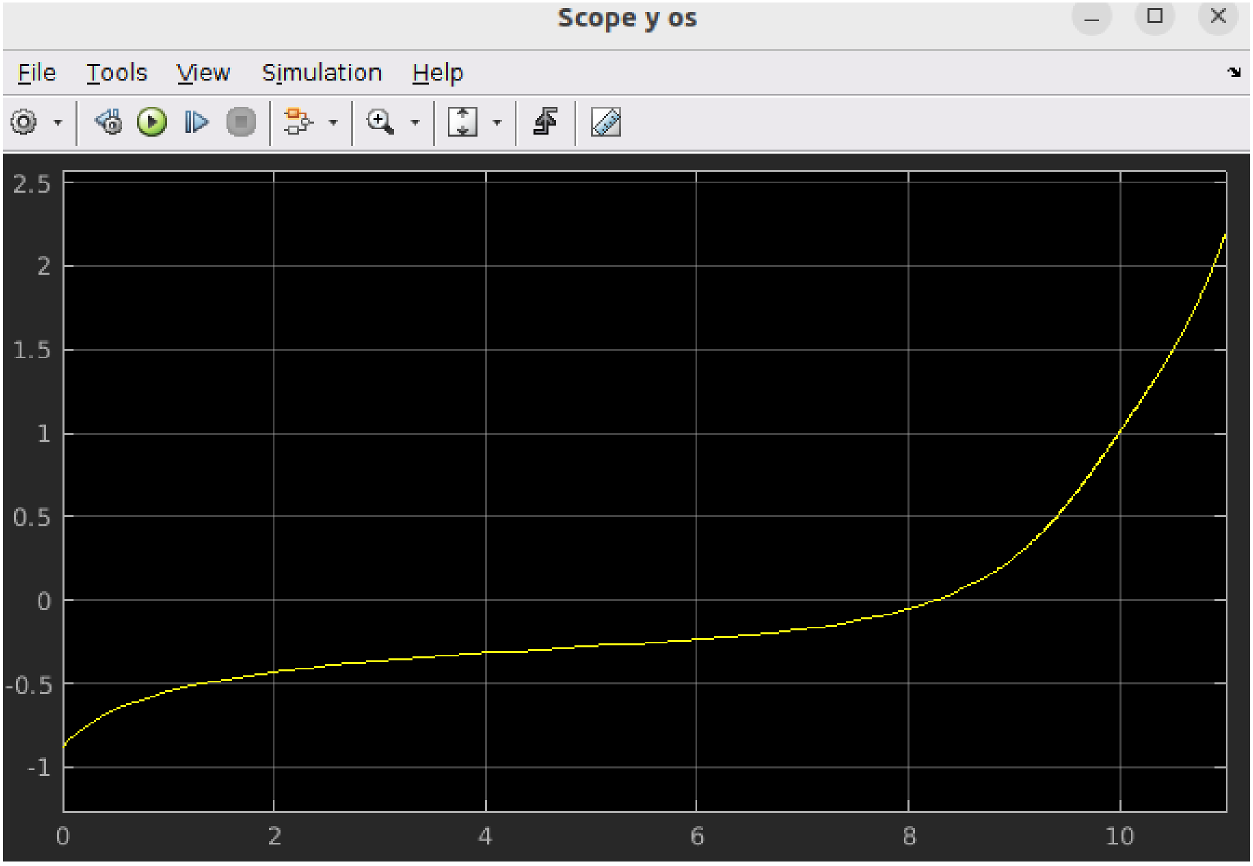
Подмодель ошибки:



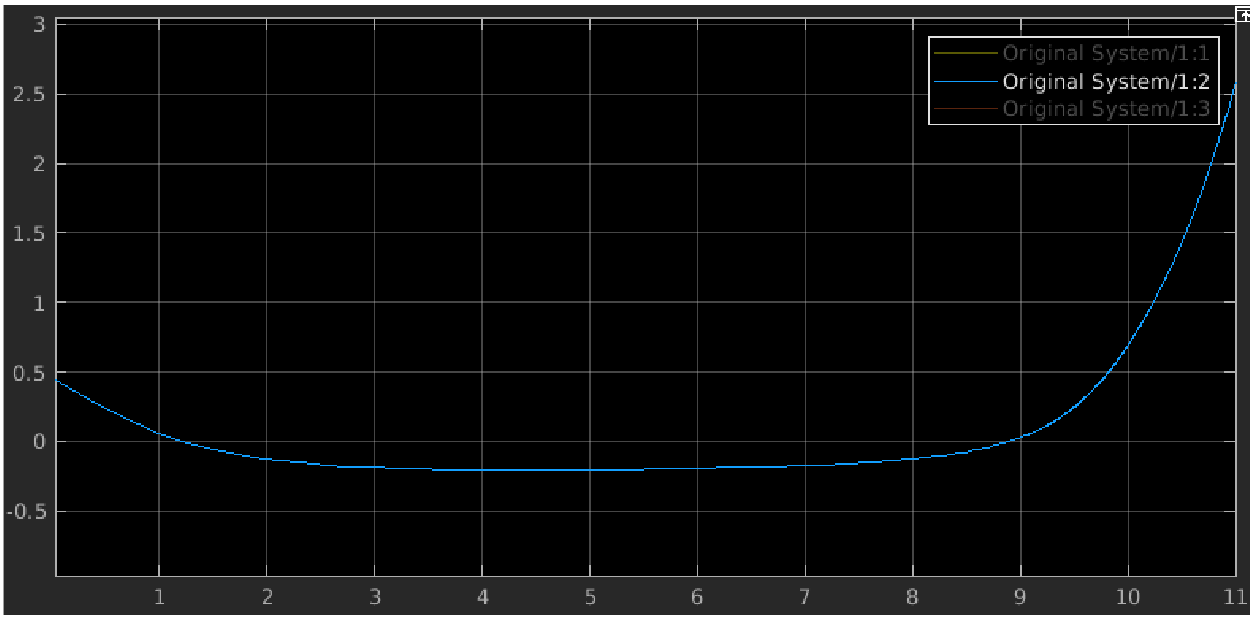
Графики вектора состояния *x*:



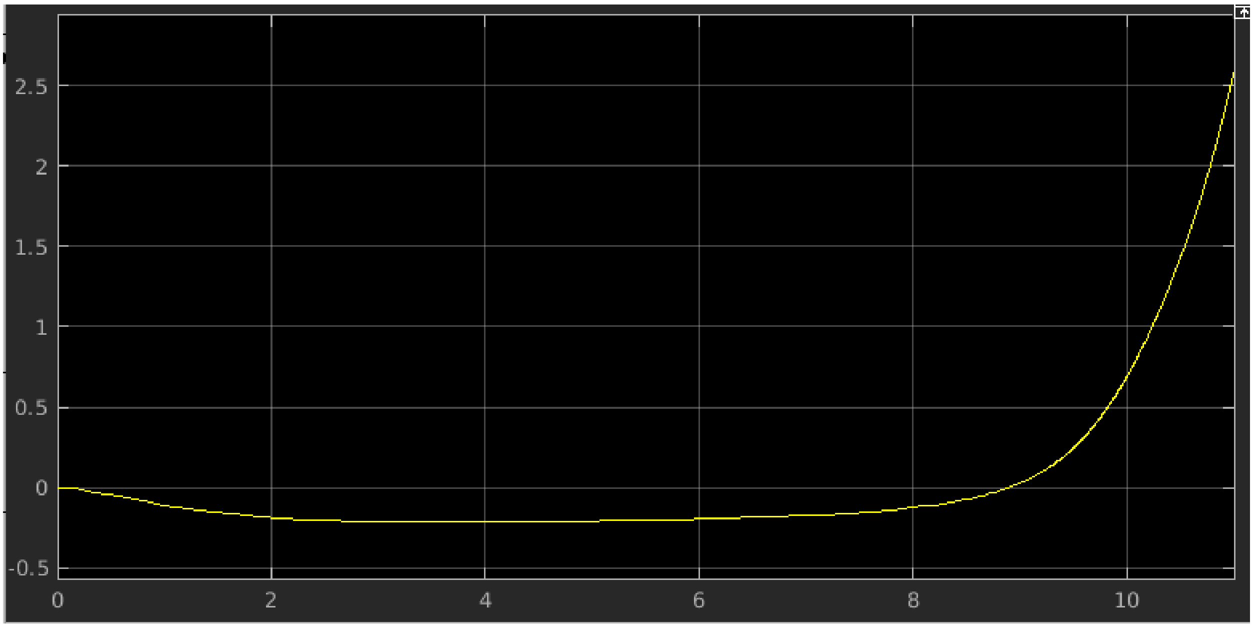
Выход *y*:



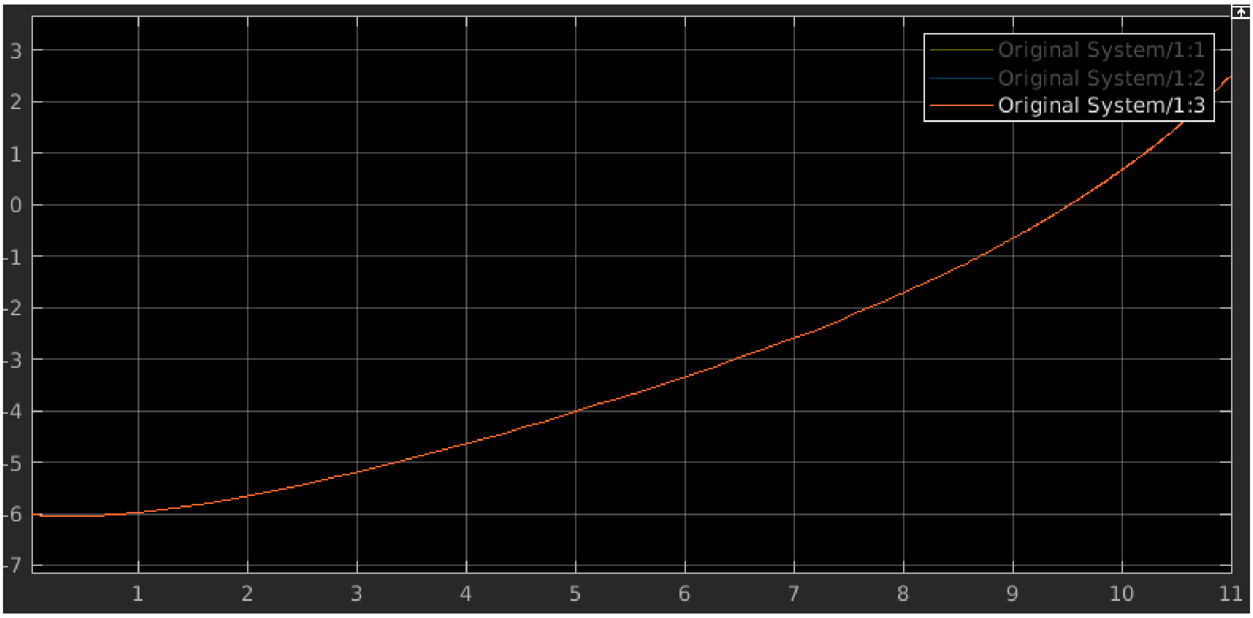
x_2 оригинальной модели:



.$\widehat{x_2}$ наблюдателя



x_3 оригинальной модели:



$\widehat{x_3}$ наблюдателя

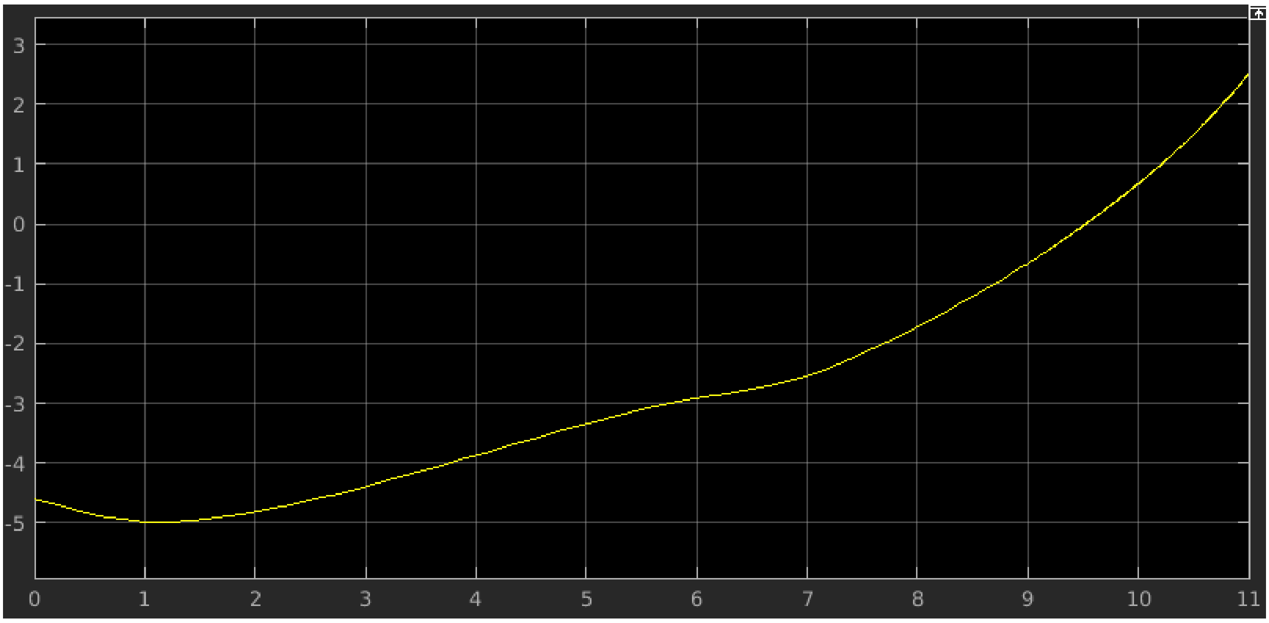
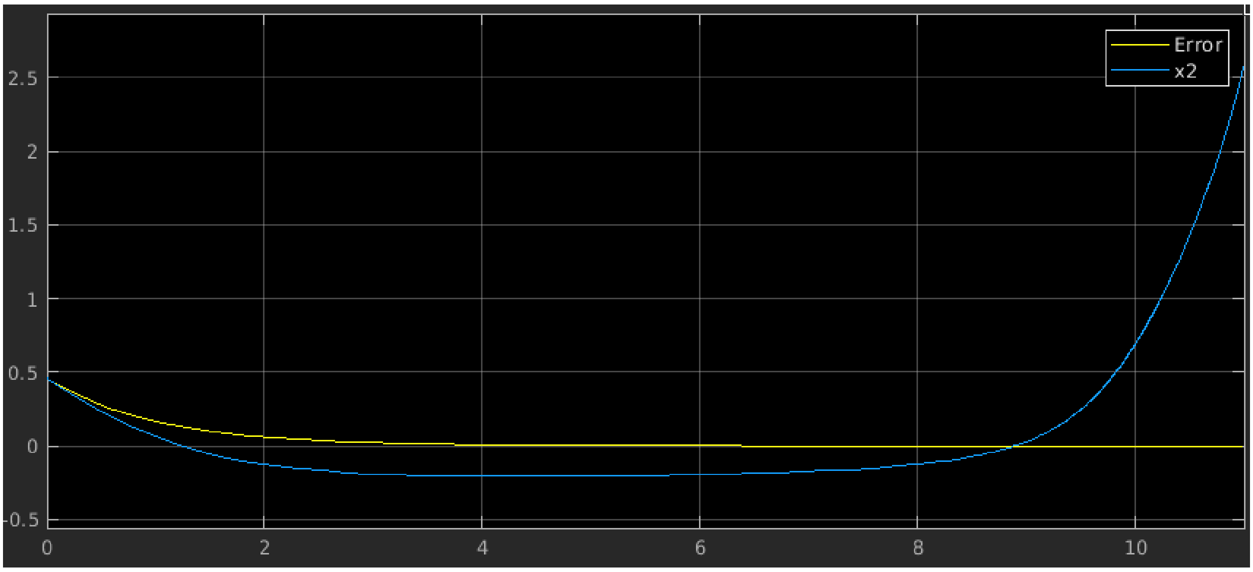


График ошибки для x_2



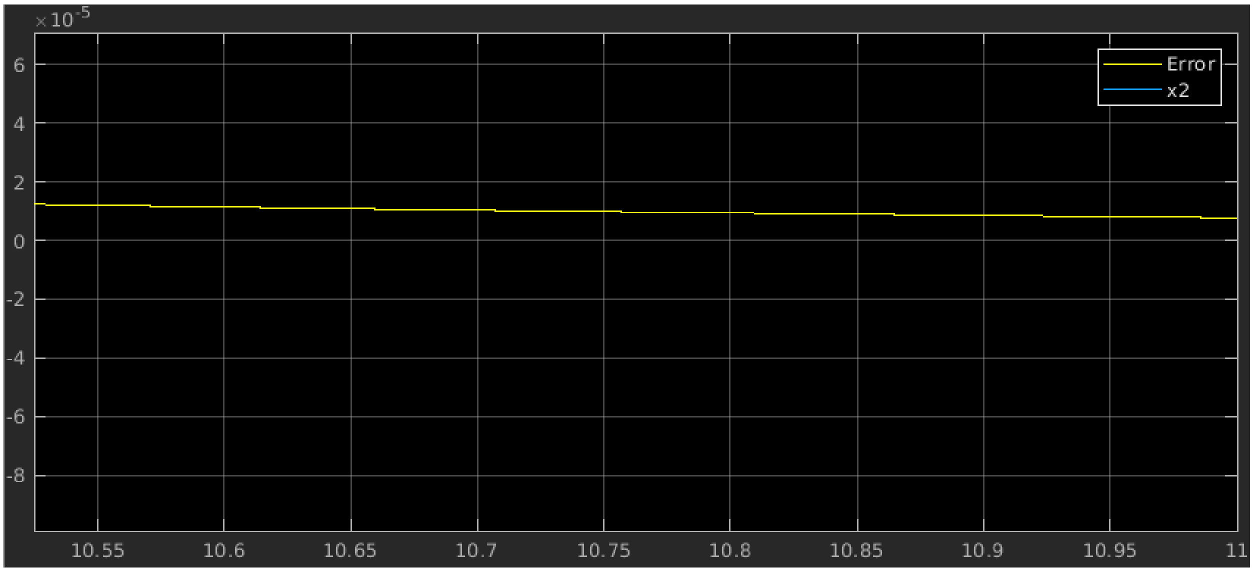


График ошибки для x_3