Intelligens Fejlesztőeszkozok - 7. beadandó

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November 2022

1 feladat

$$\ddot{q} = \alpha q + \delta \dot{q} + \beta q^3 + u \tag{1}$$

Trajektória:

$$q^N = Asin(\omega t) \Rightarrow \dot{q} = A\omega cos(\omega t); \ddot{q} = -A\omega^2 sin(\omega t) \tag{2}$$

ahol

$$\omega = 0.5$$

és

$$A = 2$$

és a szimuláció hosssza

$$2e4$$

Hiba metrika:

$$\begin{aligned} S = \left(\frac{d}{dt} + \Delta\right)^n h_{int} \Rightarrow \\ h_{int} = \int_{t_0}^{t} q^N(t) - q(t)\, dt \Rightarrow \\ \Rightarrow PID = \left(\frac{d}{dt} + \Delta\right)^n_{h_{int}} \end{aligned} \tag{3}$$

approx inverz modell:

$$\begin{aligned} 0 = -\ddot{q} + \alpha q + \delta \dot{q} + \beta q^3 + u \\ u = \ddot{q} - \alpha q - \delta \dot{q} - \beta q^3 \end{aligned} \tag{4}$$

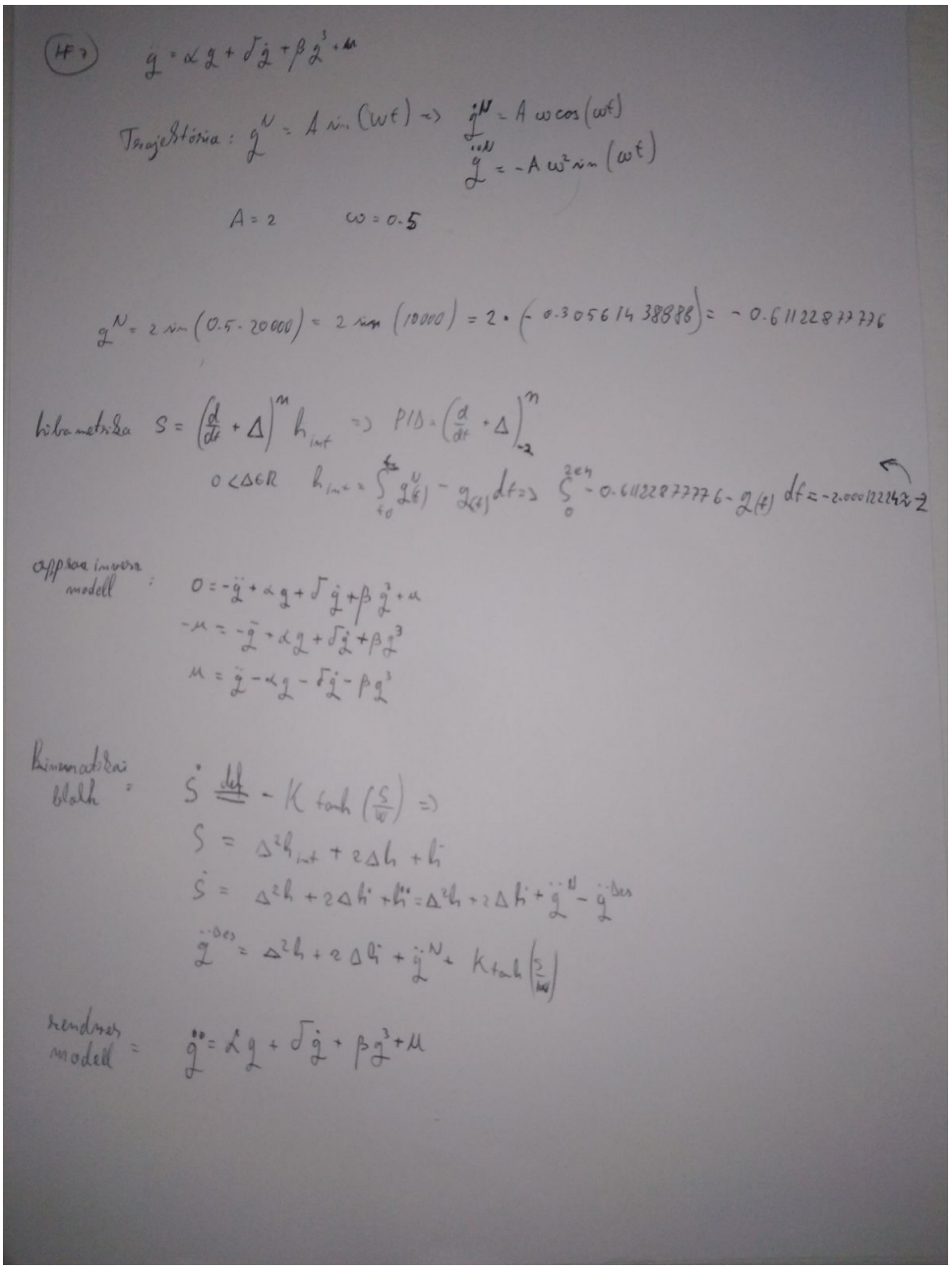
kinematikai blokk:

$\dot{S} \stackrel{def}{=} -Ktanh(\frac{S}{W}) \Rightarrow$

$$
\begin{aligned}
S &= \Delta^2 h_{int} + 2\Delta h + \dot{h} \\
\dot{S} &= \Delta^2 h + 2\Delta\dot{h} + \ddot{h} = \Delta^2 h + 2\Delta\dot{h} + \ddot{q}^N - \ddot{q}^{Des} \\
\ddot{q}^{Des} &= \Delta^2 h + 2\Delta\dot{h} + \ddot{q}^N + Ktanh(\frac{S}{W})
\end{aligned}
\tag{5}
$$

rendszer modell:

$$\ddot{q} = \alpha q + \delta\dot{q} + \beta q^3 + u \tag{6}$$

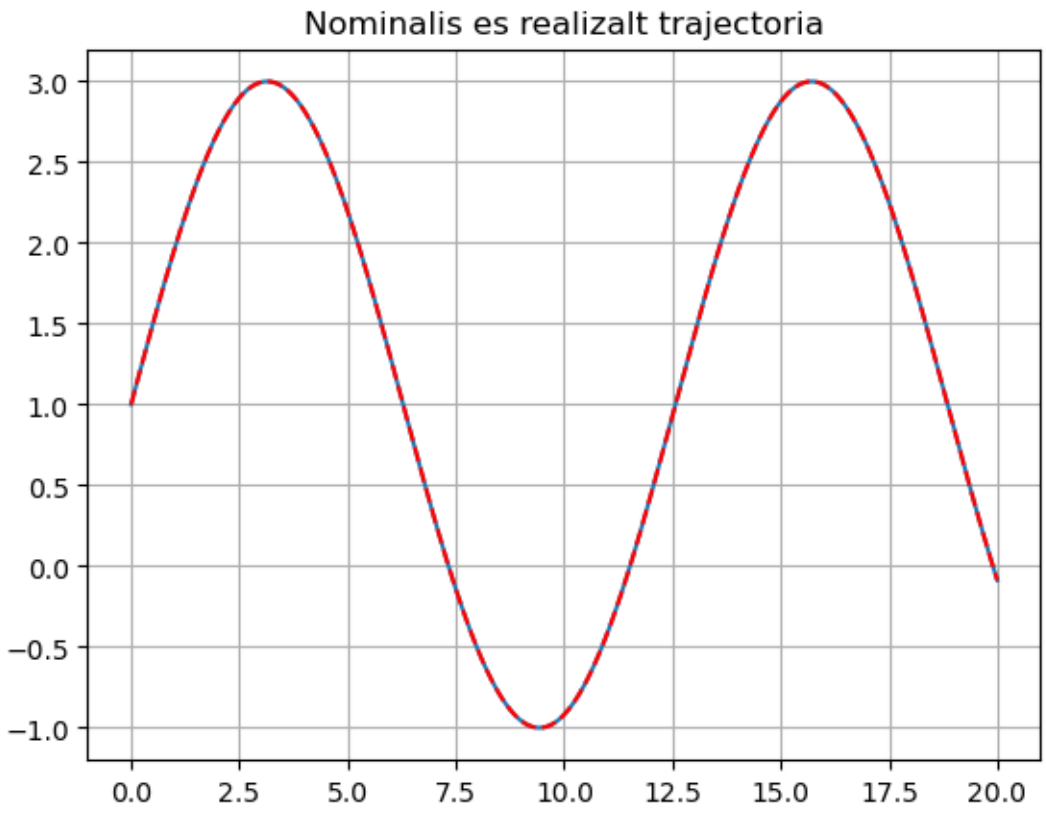


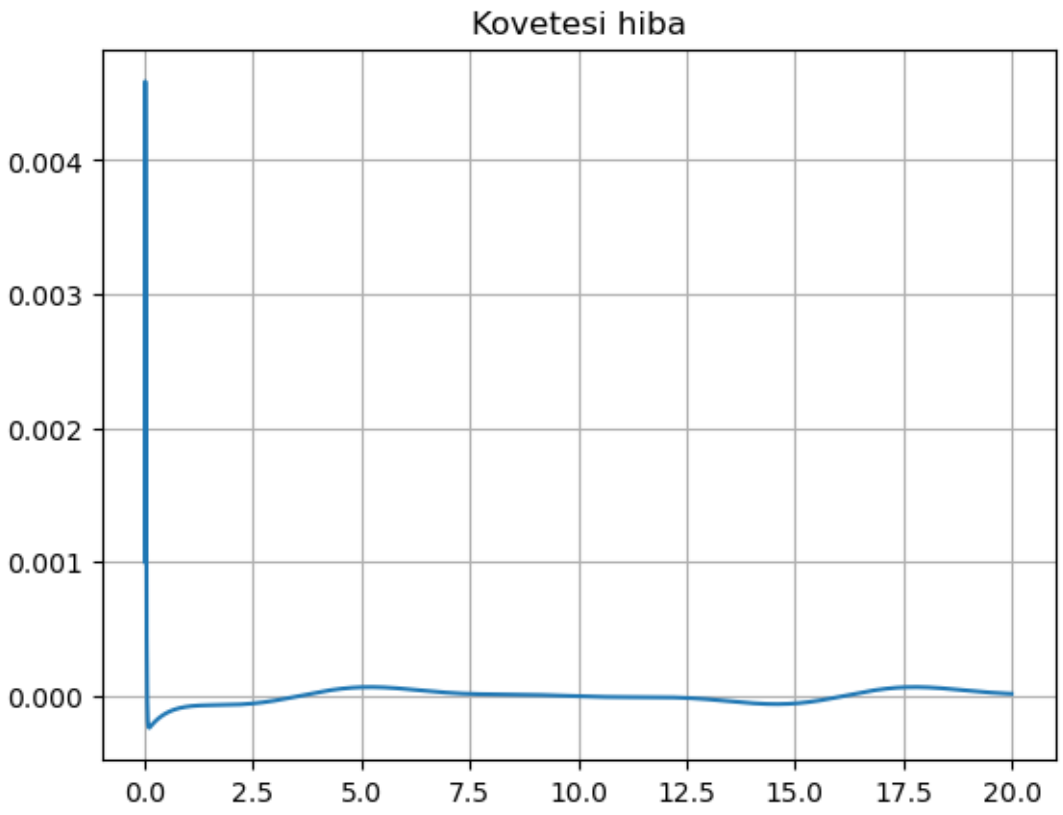
Ehhez plotok, ha:

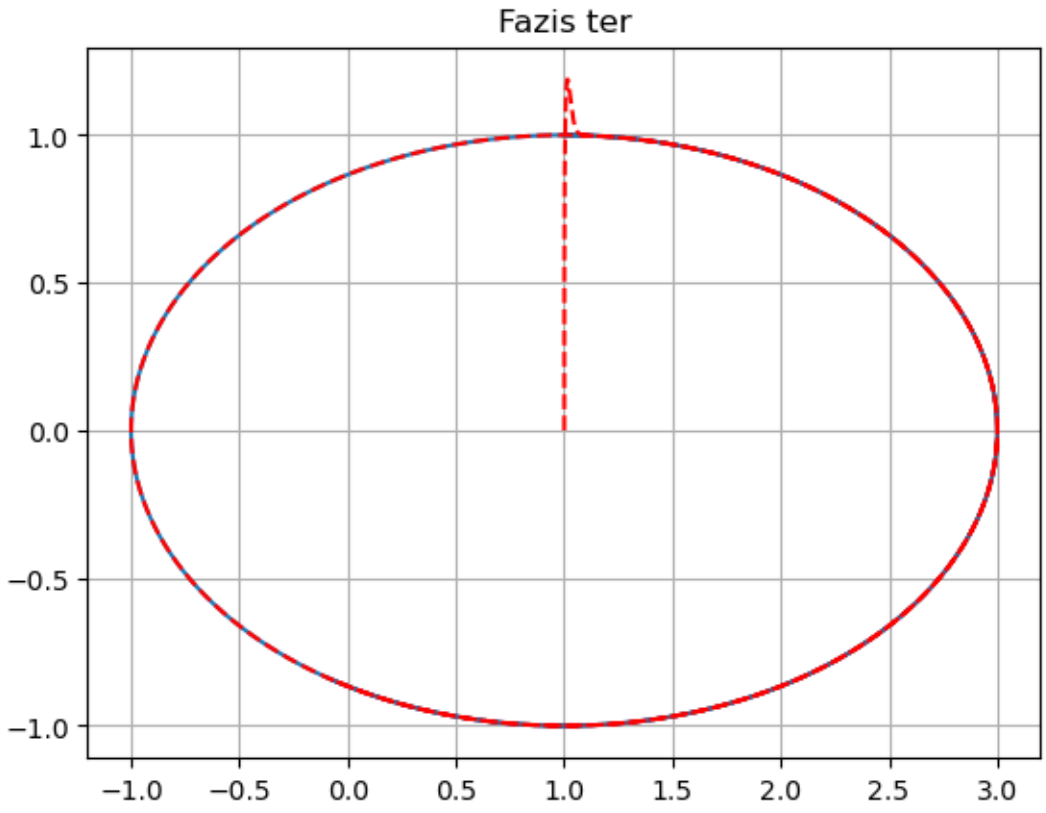
$$q_0 = 0$$

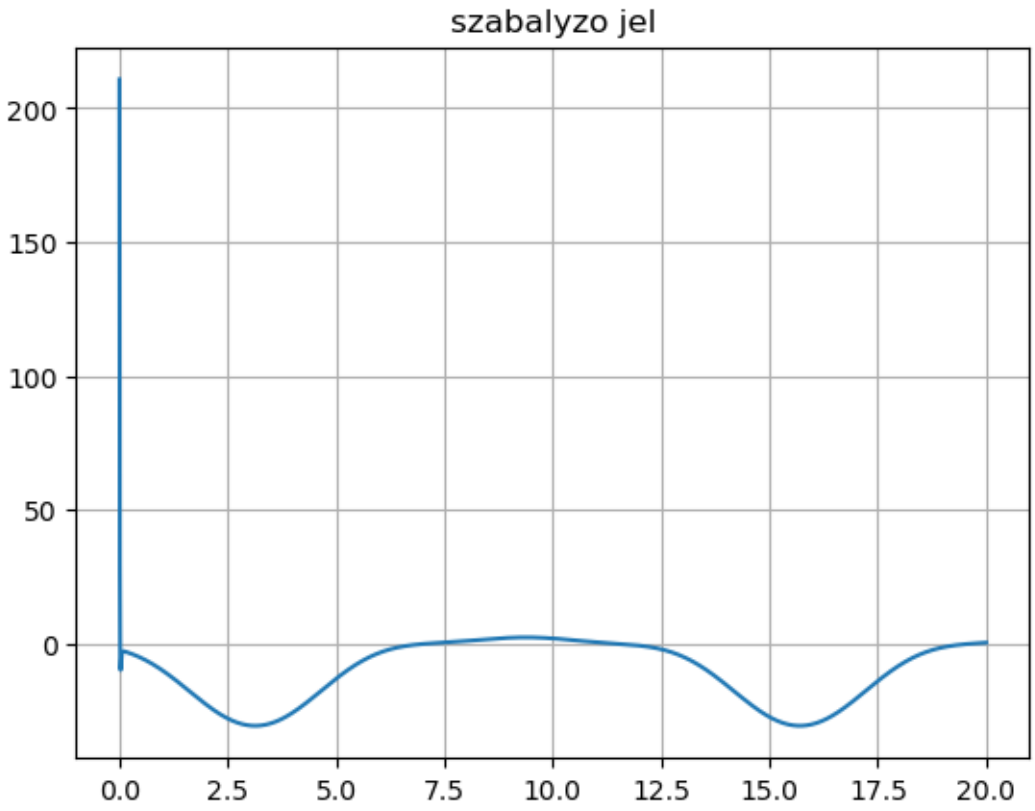
és

$$\dot{q}_0 = 0$$


Nominalis es realizalt trajectoria
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Kovetesi hiba
0.004
0.003
0.002
0.001
0.000
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Fazis ter
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0

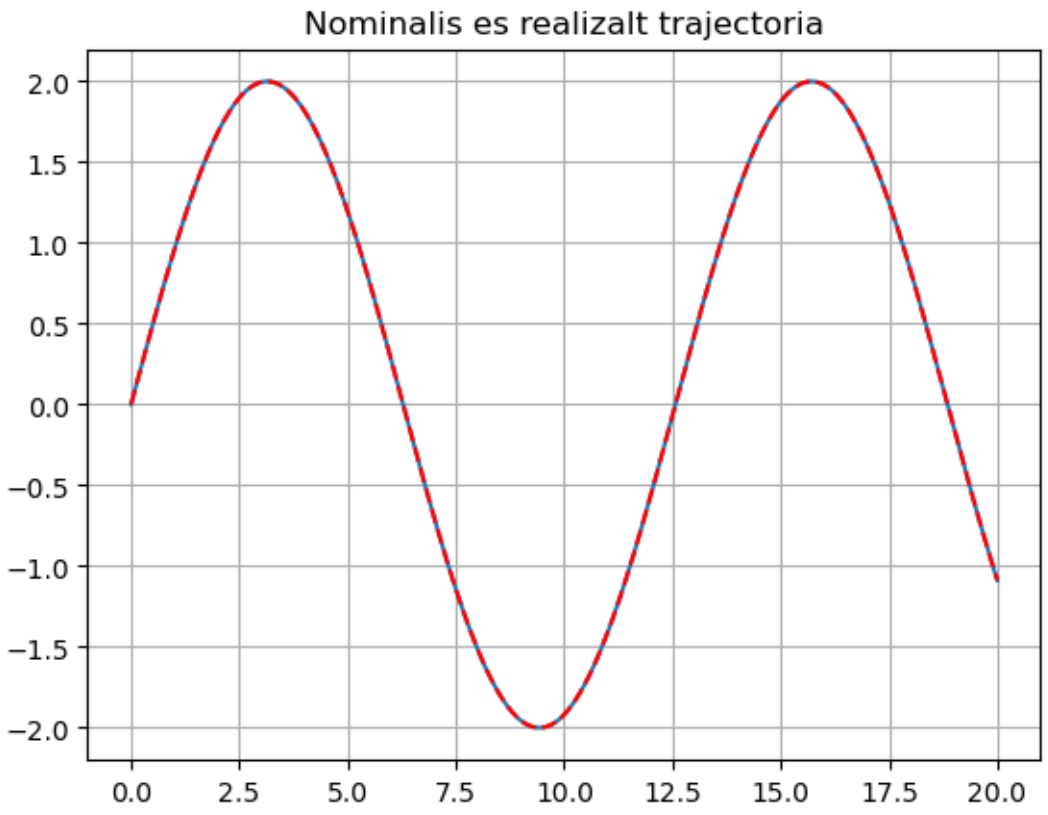


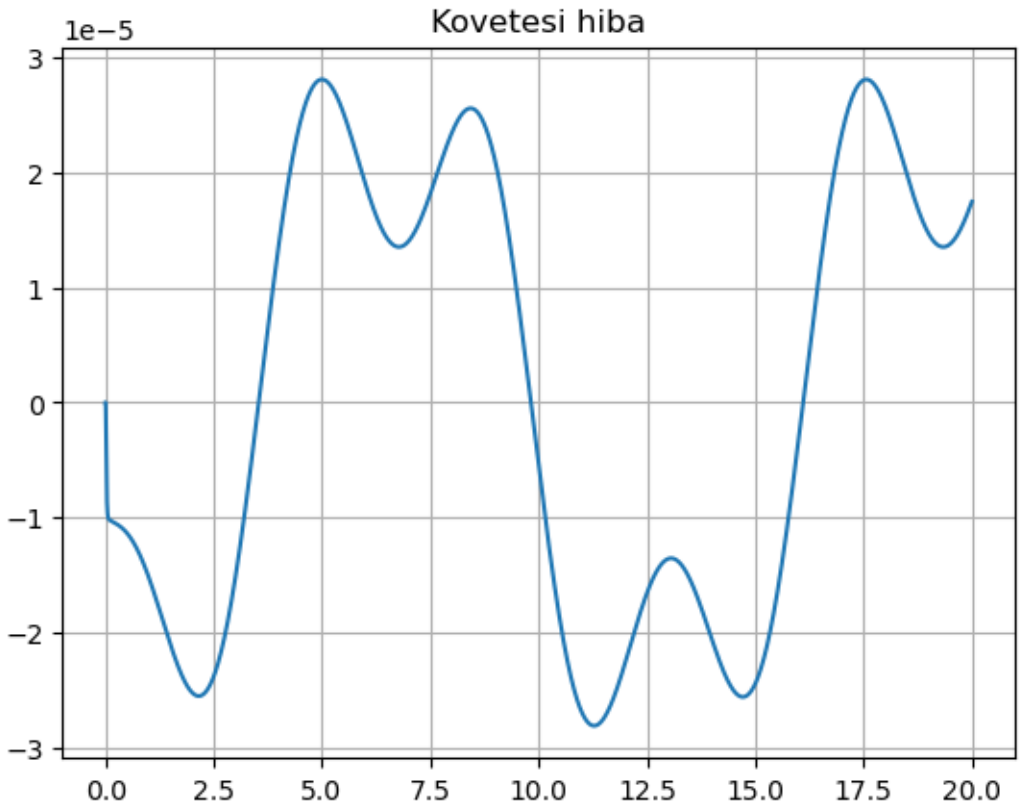
valamint ha

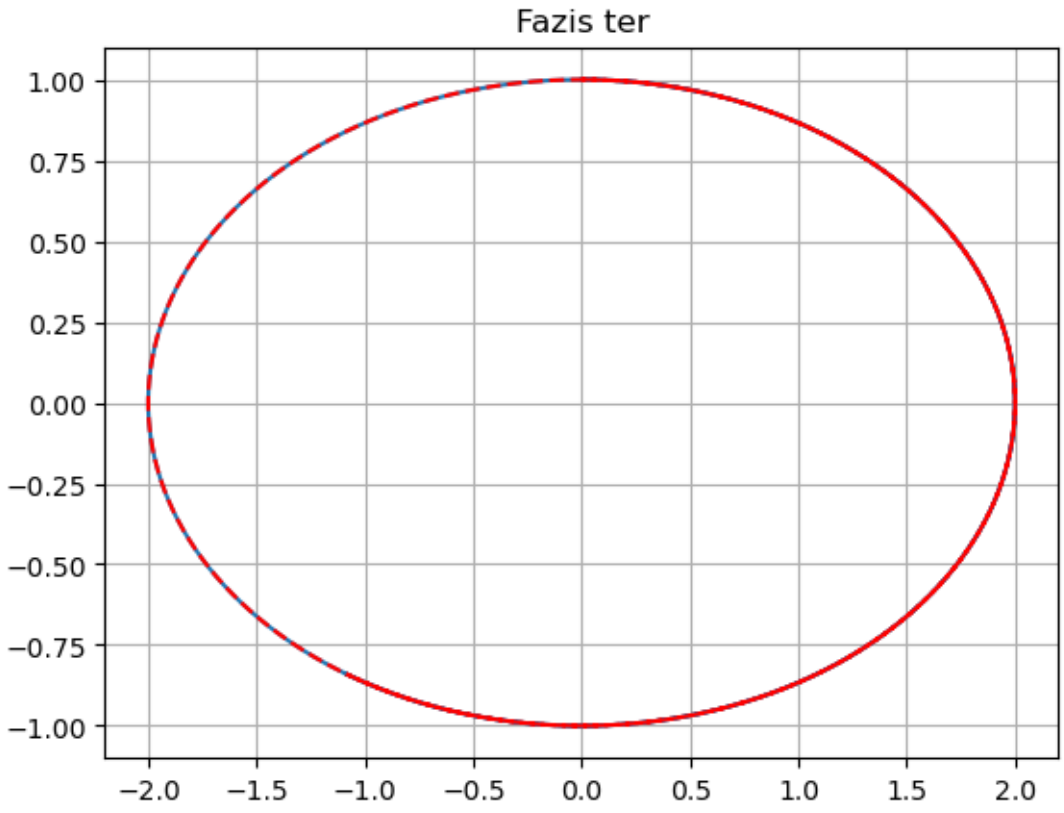
$$q_0 = q^N = Asin(\omega\delta t)$$
$$\dot{q}_0 = \dot{q}^N = A\omega cos(\omega\delta t) \tag{7}$$

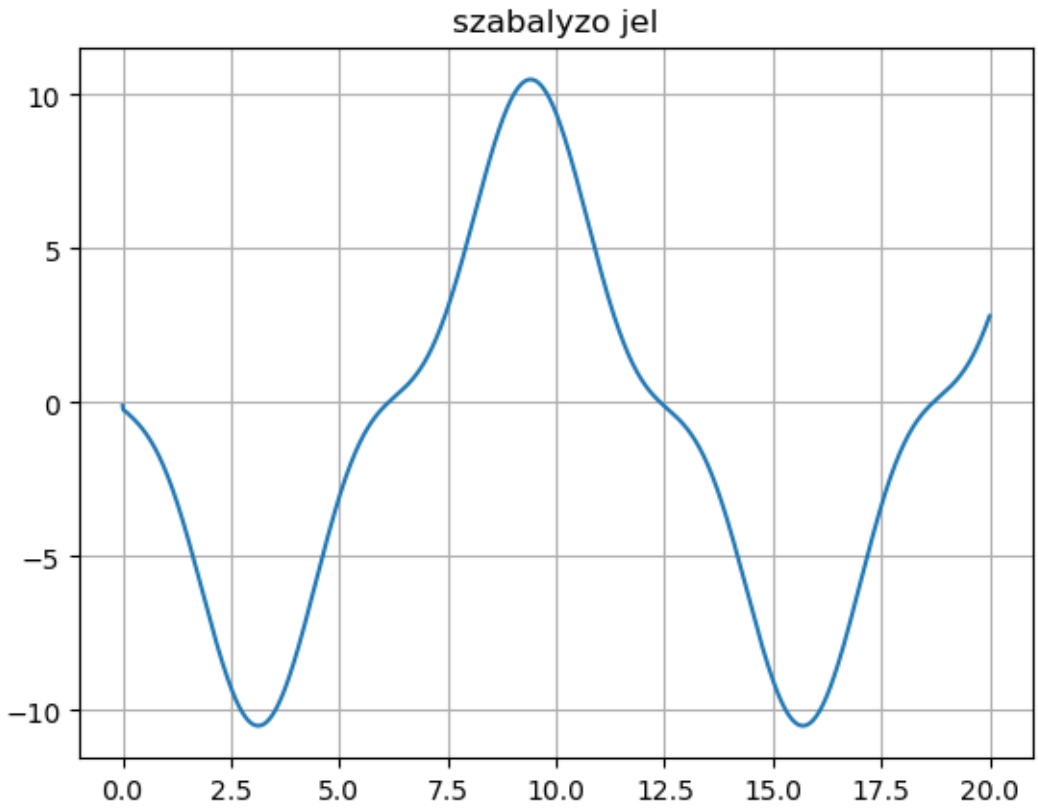
ahol $\delta t = 1e^{-3}$ ezért

$$q_0 = Asin(\omega 0.001)$$
$$\dot{q}_0 = A\omega cos(\omega 0.001)$$
$$q_0 = 2sin(0.50.001) = 0.00099999995$$
$$\dot{q}_0 = 20.5cos(0.50.001) = 0.999999875 \tag{8}$$


Nominalis es realizalt trajectoria
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Kovetesi hiba
1e−5
3
2
1
0
−1
−2
−3
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

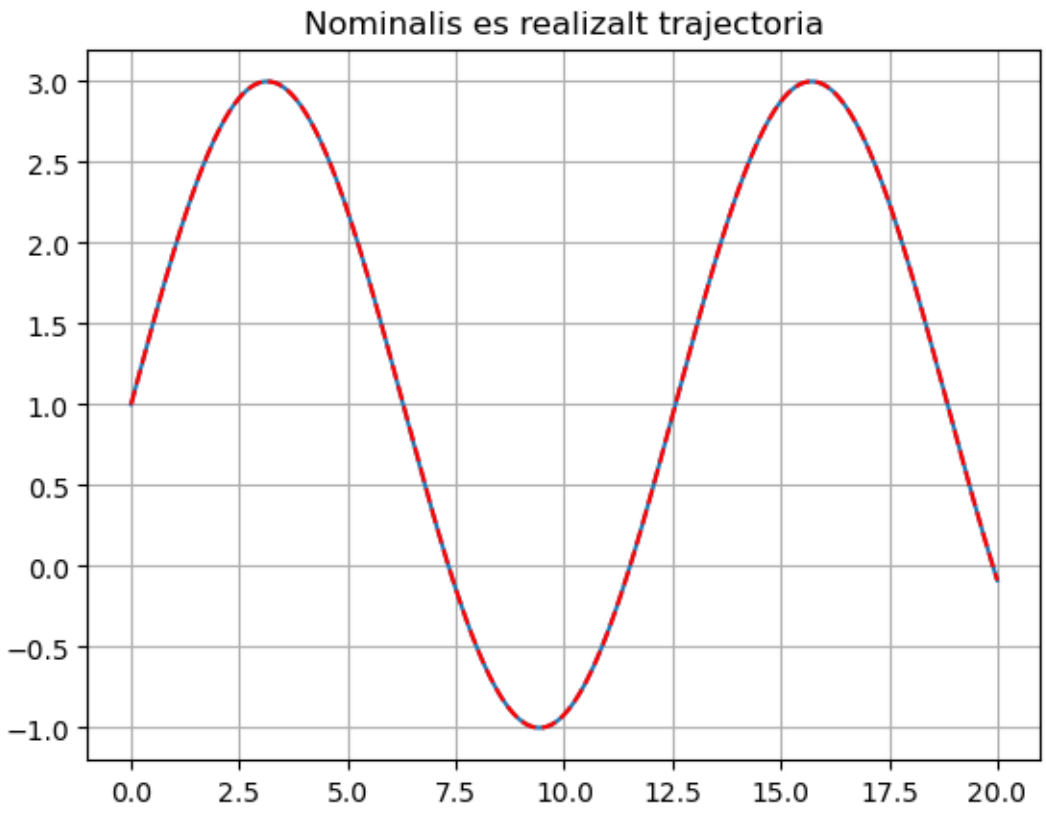

Fazis ter
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0

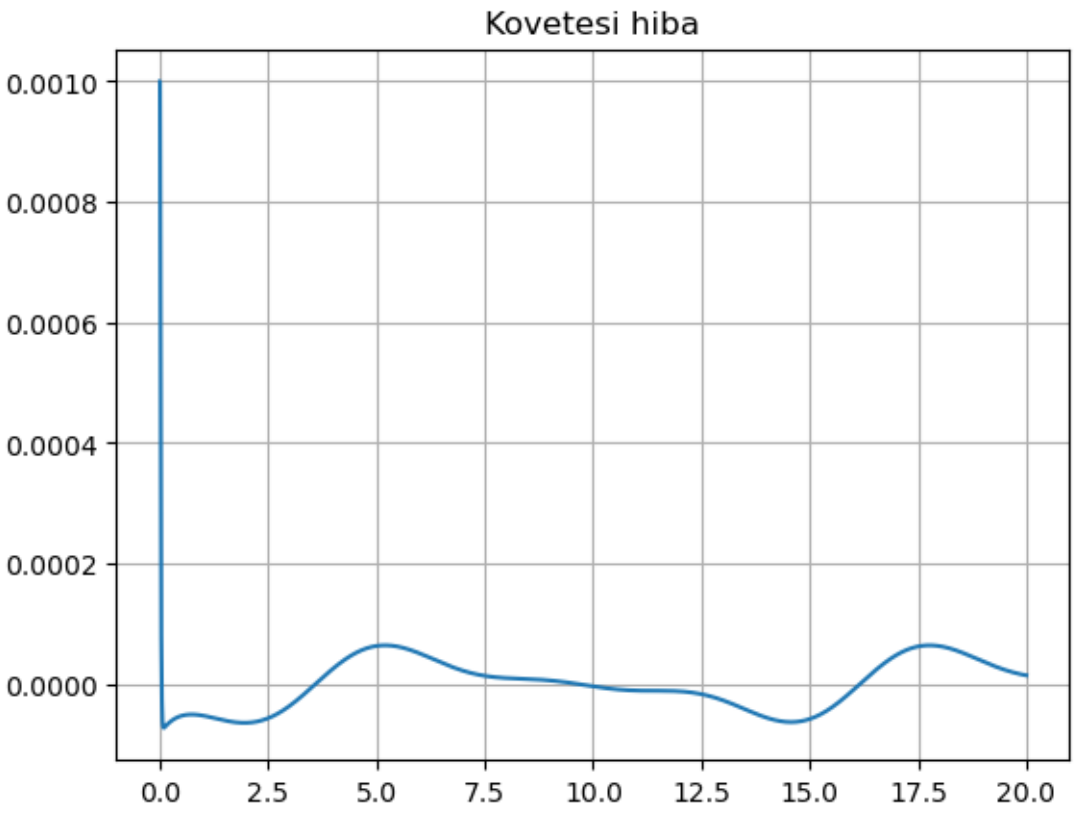


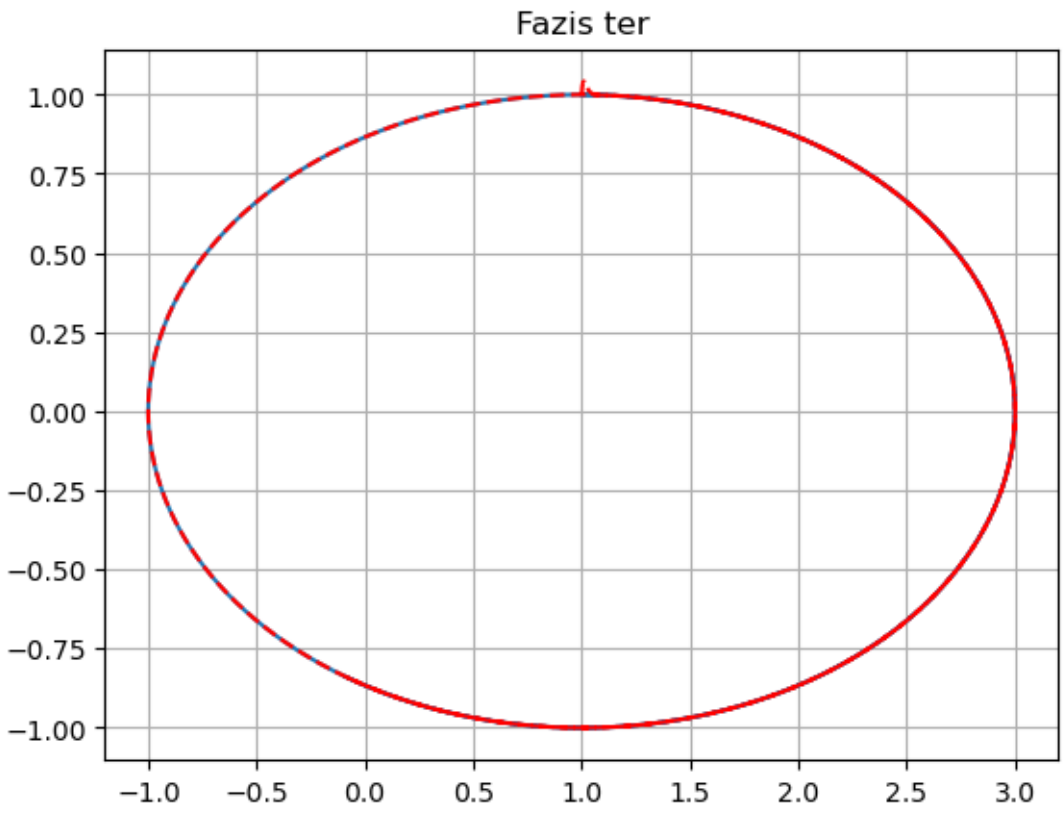
$$q_0 = 1$$

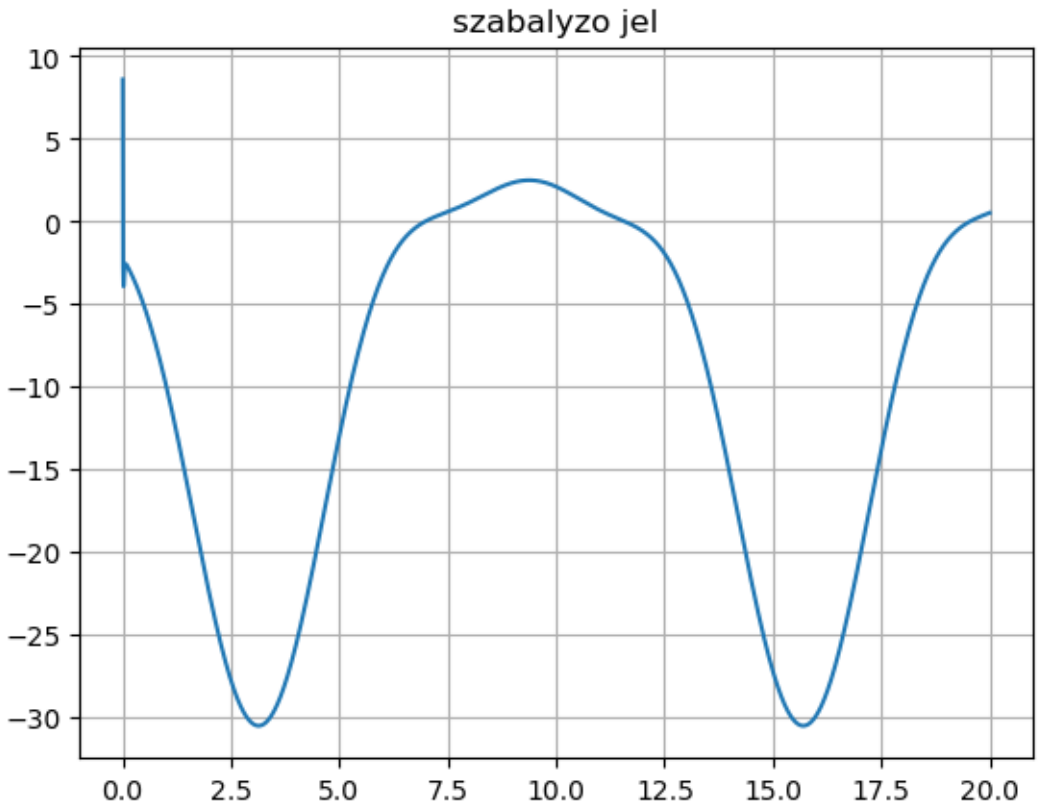
és

$$\dot{q_0} = 1$$


Nominalis es realizalt trajectoria
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Kovetesi hiba
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Fazis ter
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0

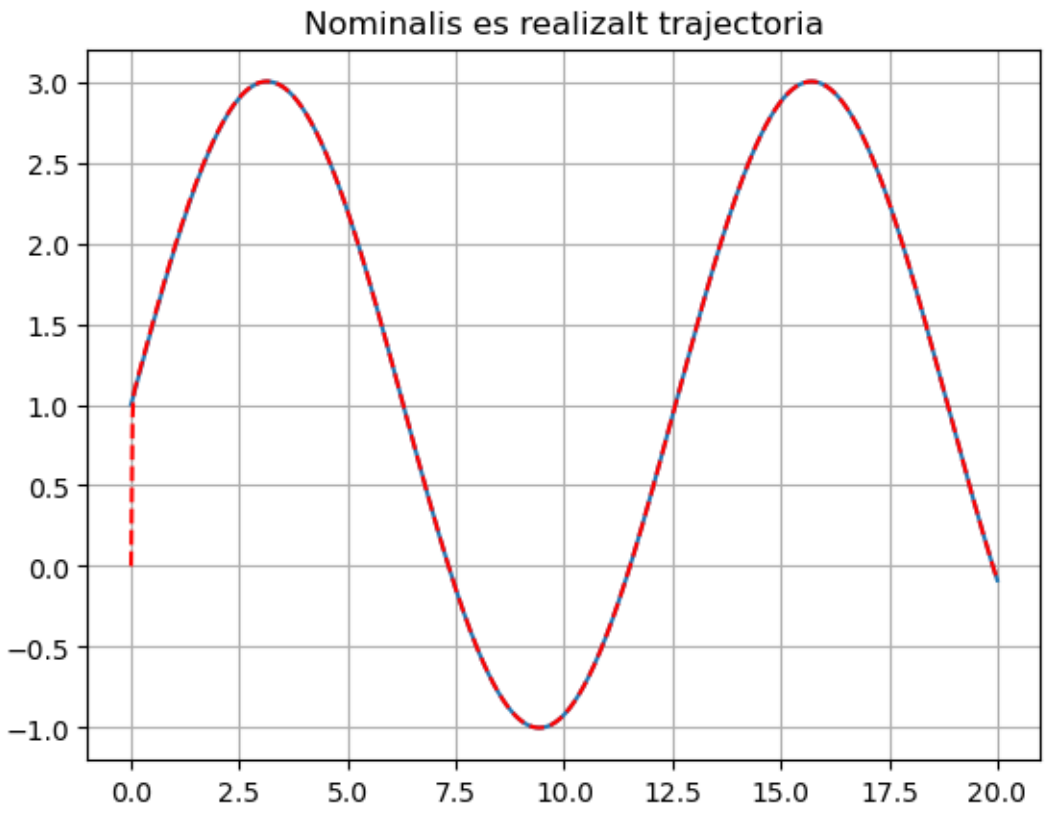


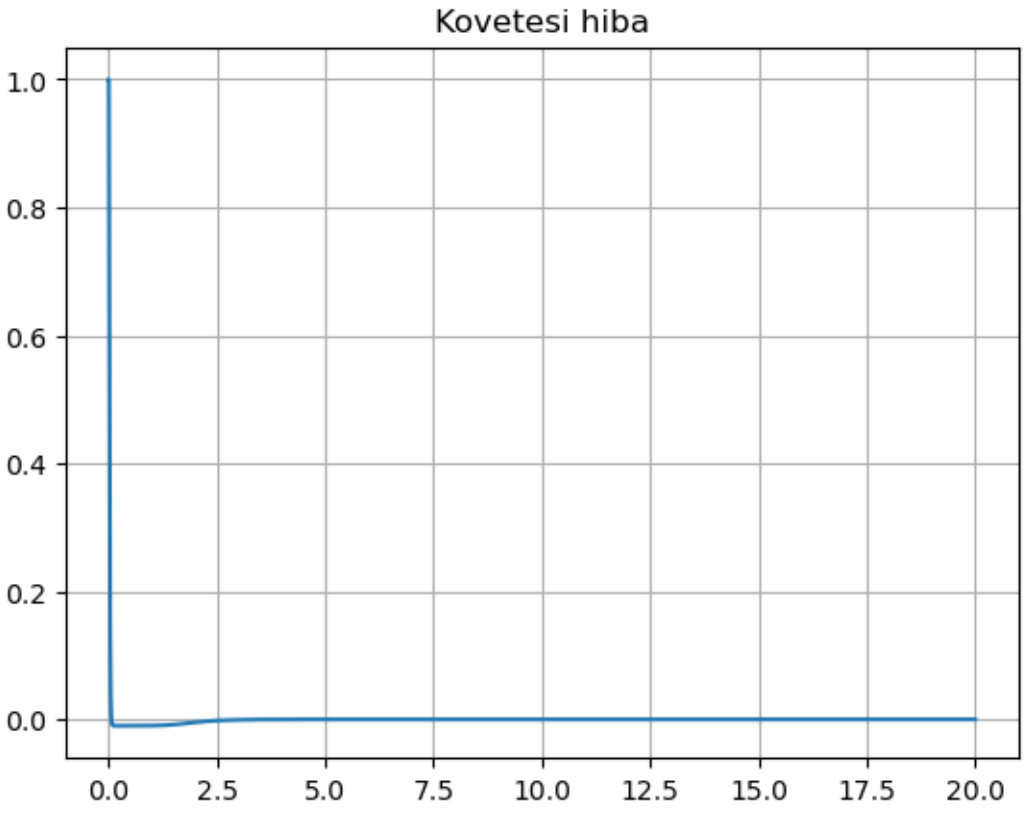
valamint ha

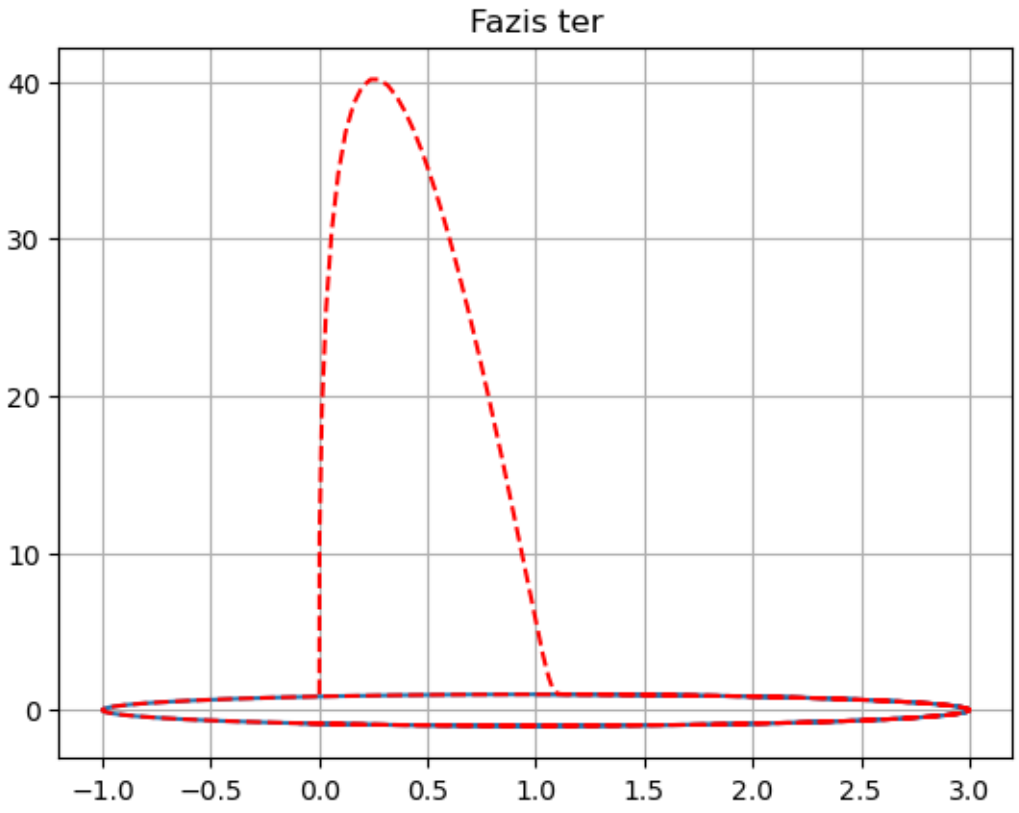
$$q_0 = A\omega cos(\omega t)$$

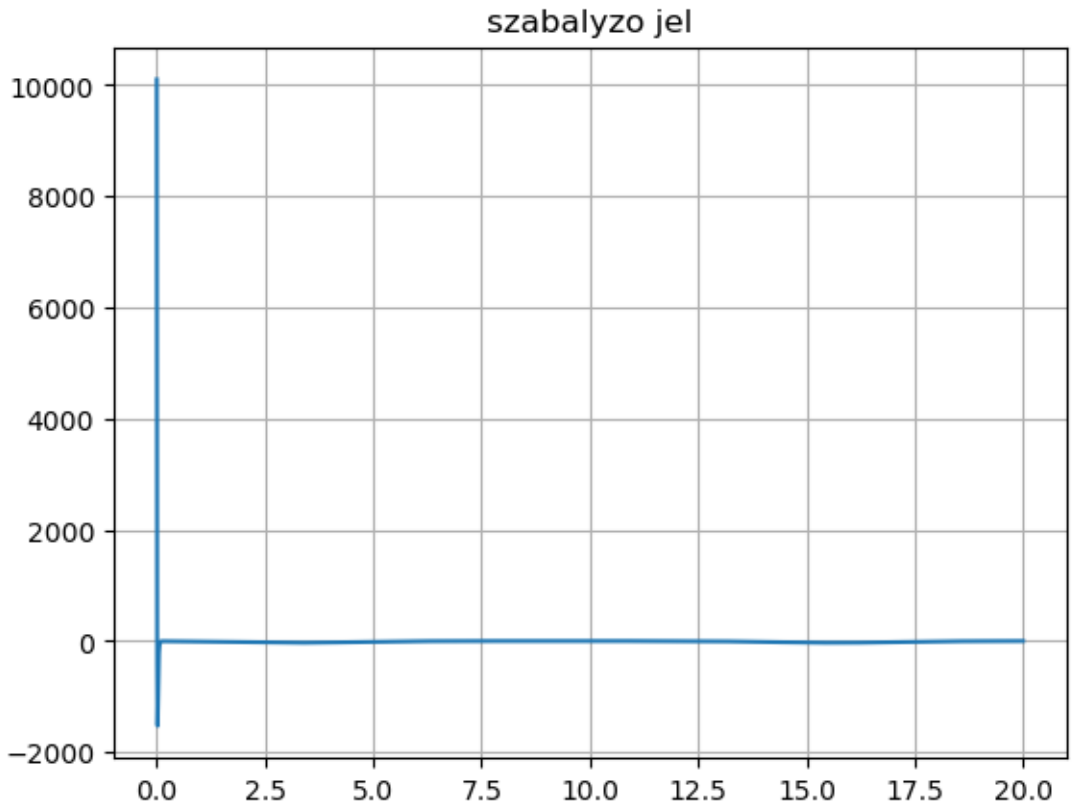
és

$$\dot{q_0} = -A\omega^2 sin(\omega t)$$


Nominalis es realizalt trajectoria
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Kovetesi hiba
1.0
0.8
0.6
0.4
0.2
0.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Fazis ter
40
30
20
10
0
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0


szabalyzo jel
10000
8000
6000
4000
2000
0
−2000
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0