1) a) $XY = 2$

$$F(s) = \frac{K}{Ts+1} \Rightarrow F(i\omega) = \frac{K}{T(i\omega)+1} \Rightarrow \boxed{F(s) = \frac{4}{5s+1}}$$

$$P = [2; -2i]; \omega = 0{,}2$$

$$2 - 2i = \frac{K}{T \cdot 0{,}2i + 1} \quad / \cdot T \cdot 0{,}2i + 1$$

$$(2 - 2i)(T \cdot 0{,}2i + 1) = K$$

$$0{,}4Ti + 2 + 0{,}4T - 2i = K$$

Re:

$$2 + 0{,}4T = K$$
$$2 + 0{,}4 \cdot 5 = K$$
$$4 = K$$

Im:

$$0{,}4TX - 2X = 0$$
$$0{,}4TX = 2X \quad / : 0{,}4$$
$$T = 5$$

b) $u(t) = 3\sin(2t)$

$$u(s) = \frac{6}{s^2+4}$$

$$F(s) = \frac{4}{5s+1} \cdot \frac{6}{s^2+4} = \frac{24}{5s^3 + 20s + s^2 + 4} = \frac{24}{5s^3 + s^2 + 20s + 4}$$

$$F(i\omega) = \frac{4}{5i\omega + 1} \cdot \frac{6}{i^2\omega^2 + 4} = \frac{24}{5i^3\omega^3 + i^2\omega^2 + 20i\omega + 4} = \frac{24}{(i\omega)(-5\omega^2 + 20) + 4 - \omega^2} =$$

($-5i^3\omega^3$, $-\omega^2$)

$$= \frac{24}{(i\omega)(-5\omega^2 + 20) + (4 - \omega^2)} \cdot \frac{(i\omega)(-5\omega^2 + 20) - (4 - \omega^2)}{(i\omega)(-5\omega^2 + 20) - (4 - \omega^2)} = \frac{24\left((i\omega)(-5\omega^2 + 20) + (4 - \omega^2)\right)}{(-5\omega^2 + 20)^2 - (4 - \omega^2)^2}$$

Re:

$$\frac{24(4-\omega^2)}{(-5\omega^2+20)^2+(4-\omega^2)^2} \overset{\omega=0,2}{=} 0,233$$

Im:

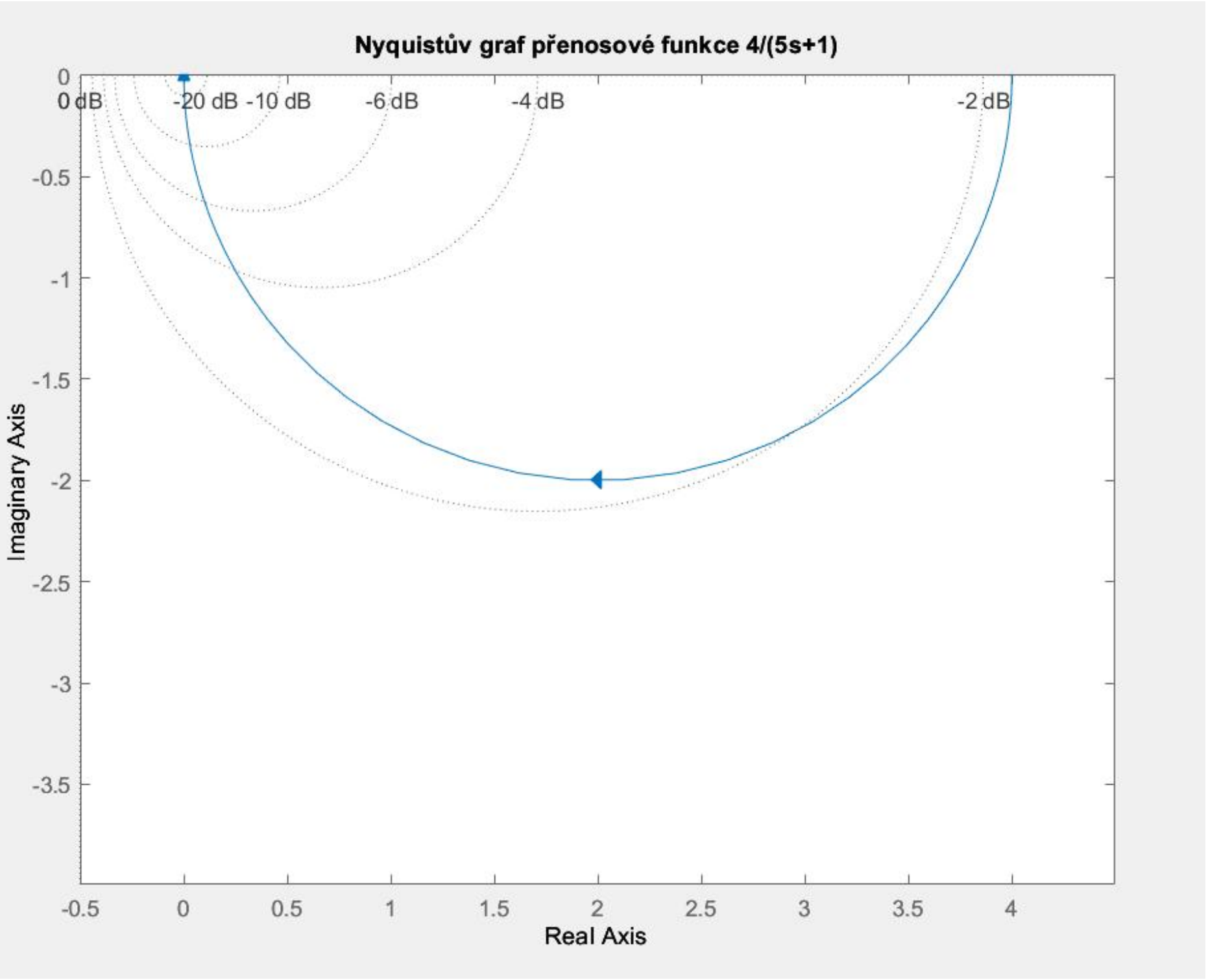
$$\frac{24(i\omega)(-5\omega^2+20)}{(-5\omega^2+20)^2+(4-\omega^2)^2} \overset{\omega=0,2}{=} 0,233i$$

Amplituda

$$A = \sqrt{Re^2 + Im^2} = \sqrt{0,233^2 + 0,233^2} = 0,329$$

Fáze φ

$$\varphi = \operatorname{atg} \frac{Im}{Re} = \operatorname{atg} \frac{0,233}{0,233} = 0,785 \text{ rad}$$


Nyquistův graf přenosové funkce 4/(5s+1)
0 dB
-20 dB
-10 dB
-6 dB
-4 dB
-2 dB
Imaginary Axis
Real Axis
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4

2) $M = \frac{\pi r^2 \cdot v \cdot \rho}{3} = \frac{\pi \cdot 0{,}03^2 \cdot 0{,}1 \cdot 1{,}24}{3} = 116 \cdot 10^{-6}\ kg$

$L = 0{,}2 \cdot 2 = 0{,}4\ mH$

$$\frac{X(s)}{U(s)} = \frac{0{,}63}{s\left[(Ms+b)(Ls+R)+0{,}63^2\right]} = \frac{0{,}63}{s\left[(116s\cdot 10^{-6} + 1{,}6\cdot 10^{-3})(0{,}4s\cdot 10^{-3}+4)+0{,}63^2\right]} =$$

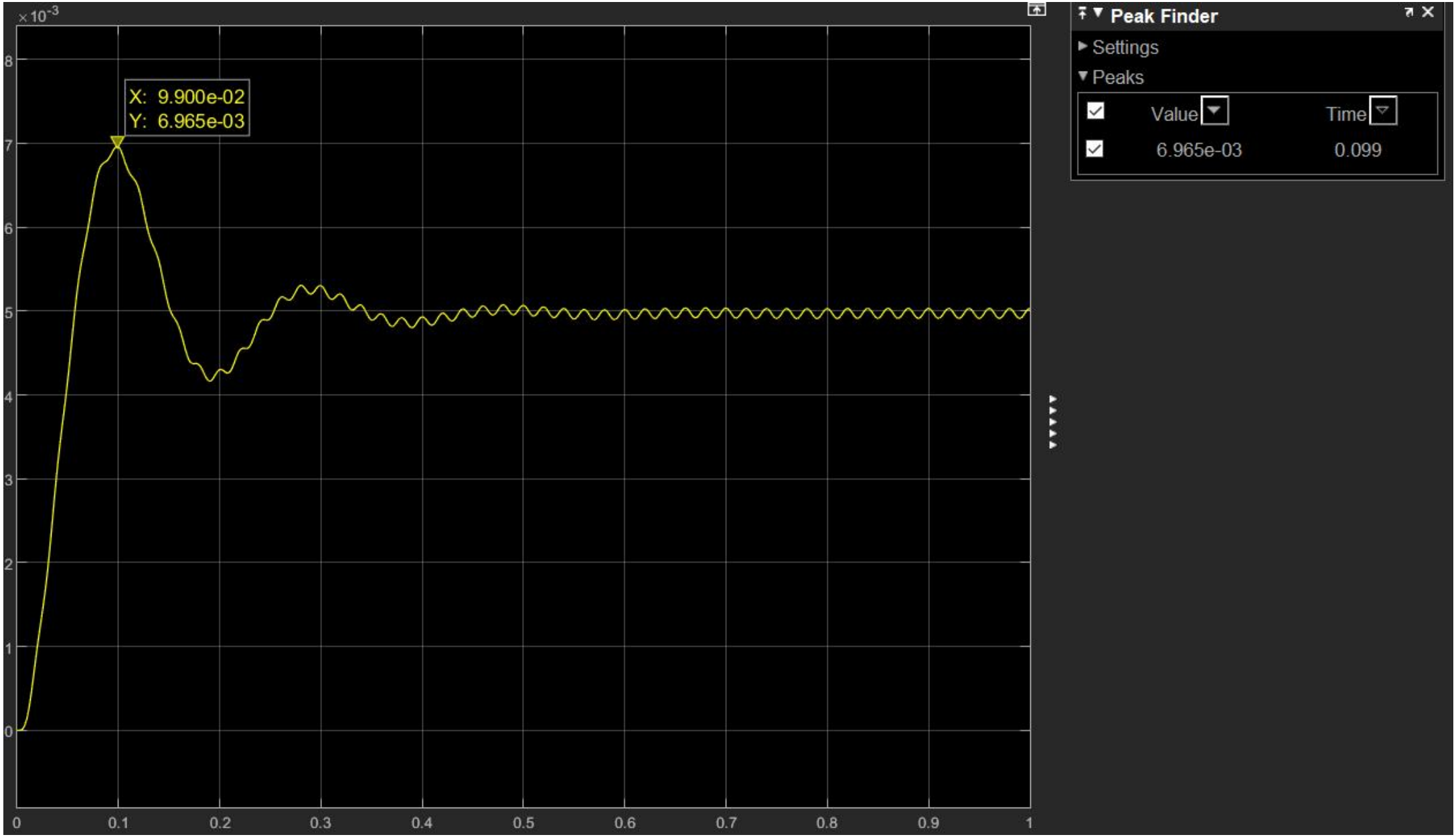
$$= \frac{0{,}63}{s\left[(116s\cdot 10^{-6} + 1{,}6\cdot 10^{-3})(0{,}4s\cdot 10^{-3}+4)+0{,}63^2\right]} = \frac{0{,}63}{s\left(4{,}64s^2\cdot 10^{-8} + 4{,}64s\cdot 10^{-4} + 6{,}4s\cdot 10^{-7} + 6{,}4\cdot 10^{-3} + 0{,}63^2\right)} =$$

$$= \frac{0{,}63}{4{,}64s^3\cdot 10^{-8} + 4{,}6464s^2\cdot 10^{-4} + 0{,}4033s} = \frac{0{,}63}{0{,}0000004464s^3 + 0{,}00046464s^2 + 0{,}4033s} =$$

$$= \frac{0{,}63}{s\left[(0{,}000116s+0{,}0016)(3s+4)+0{,}63^2\right]} = \frac{0{,}63}{s\left(0{,}000348s^2 + \underbrace{0{,}000464s + 0{,}0048s}_{0{,}006864s} + \underbrace{0{,}0064 + 0{,}63^2}_{0{,}4033}\right)} =$$

$$= \frac{0{,}63}{0{,}000348s^3 + 0{,}006864s^2 + 0{,}4033s}$$

Maximální výchylka jsou 7 mm.



Z výsledné odezvy lze vidět, že maximální vychýlení reproduktoru bude v čase t=0,1s a dojde k vychýlení o 6,965mm.
Oscilace se pak ustálí na vychýlení kolem 4,97mm.