Solution-Assignment2

a) Basic equations of the system

$$\dot{x} = \frac{1}{m}\cdot\left(\frac{2\pi}{3} d_p^3 \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^3} - k\dot{\delta}\right)\frac{\sqrt{[1-(z_n-z_p)^2]\cdot(x_n-x_p)}}{\delta}$$

$$\dot{y} = \frac{1}{m}\cdot\left(\frac{2\pi}{3} d_p^3 \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^3} - k\dot{\delta}\right)\frac{\sqrt{[1-(z_n-z_p)^2]\cdot[1-(x_n-x_p)^2]}}{\delta}$$

$$\dot{z} = \frac{1}{m}\cdot\left(\frac{2\pi}{3} d_p \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^2} - k\dot{\delta}\right)\frac{z_n-z_p}{\delta}$$

b)

$$\begin{cases} \frac{2\pi}{3} d_p^3 \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^3}\cdot\frac{x_n-x_p}{\delta} - k\dot{x}_p = 0 \\ \frac{2\pi}{3} d_p^3 \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^3}\frac{y_n-y_p}{\delta} - k\dot{y}_p = 0 \end{cases}$$

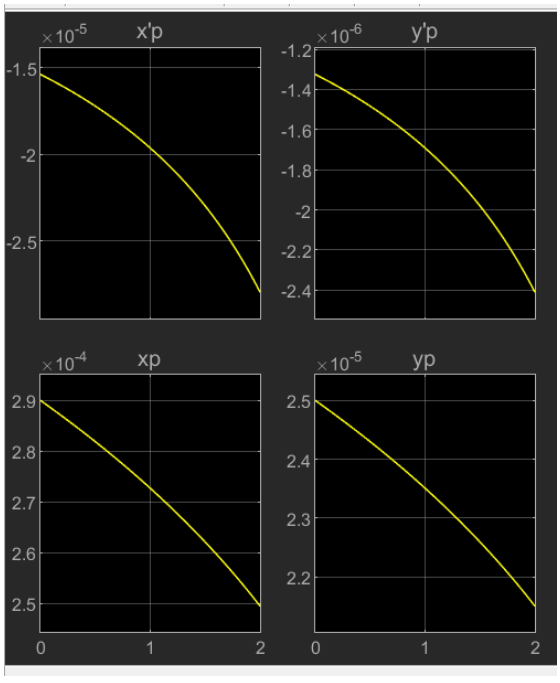
So

$$\begin{cases} \dot{x}_p = \frac{2}{9V_f} d_p^2 \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^3}\cdot\frac{x_n-x_p}{\delta} \\ \dot{y}_p = \frac{2}{9V_f} d_p^2 \rho_p M_p \frac{\beta M_n^2}{(4\beta\delta+1)^3}\cdot\frac{y_n-y_p}{\delta} \end{cases}$$

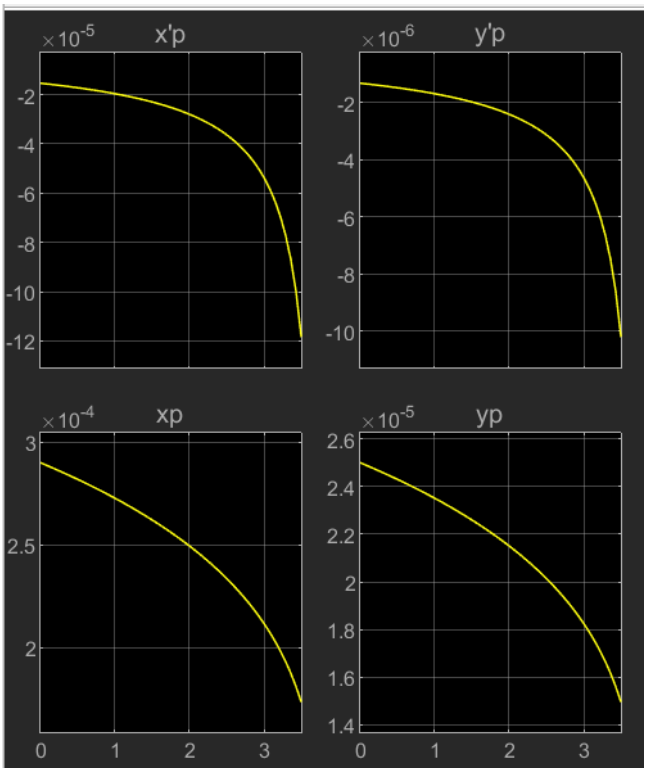
so $\lambda = \frac{2}{9V_f} d_p^2 \rho_p M_p \beta M_n^2$

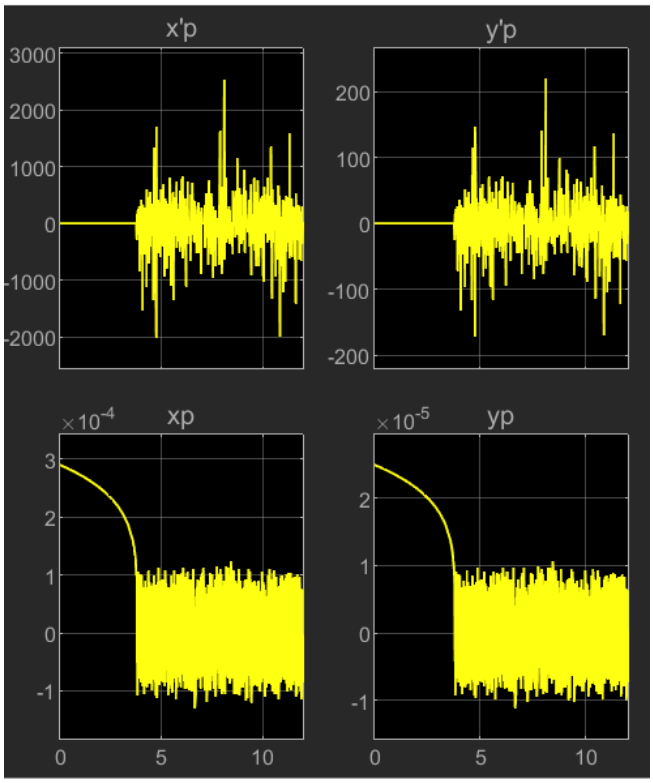
c)constant.m
model.mdl

d)



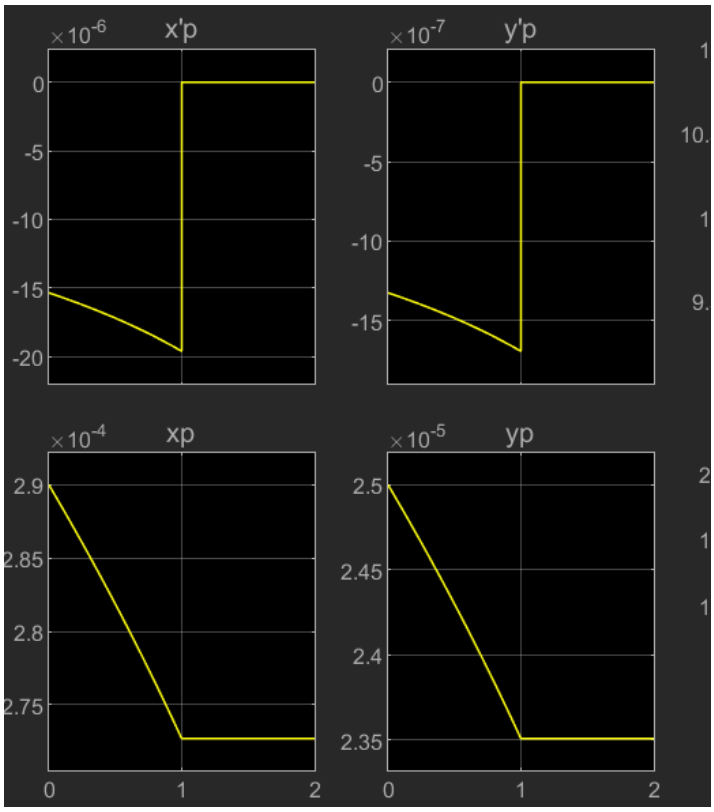
Change the simulation time to 3.5s/12s





The plot shows that the needle will contact the particle around 3.5s-4s, and start to vibracate.

e)if step is the input



f)

The velocity norm is as follows

$$V=\sqrt{(\dot{x}_p)^2+(\dot{y}_p)^2}=\frac{2}{9V_f}\alpha_p^2\rho_p M_p\frac{\beta M_2^2}{(4\beta\delta+1)^3}\cdot\frac{\sqrt{(x_n-x_p)^2+(y_n-y_p)^2}}{\delta}$$

$$\alpha=\arctan\frac{\dot{y}_p}{\dot{x}_p}=\arctan\frac{y_n-y_p}{x_n-x_p}$$

g)The needle is static