a)

Equilibrium point: $(y, \dot{y}, \ddot{y}) = (g, 0,0)$. At this point, $\ddot{y} = 0$, it remains here in the future.

b)

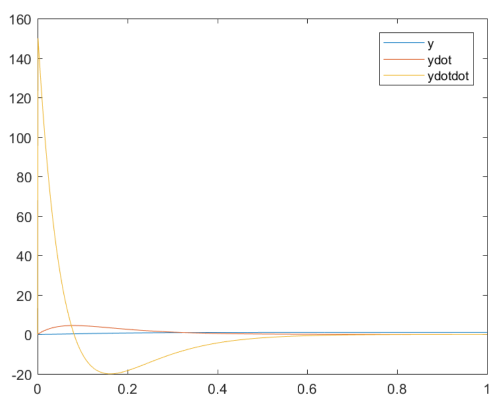
The DMP can be expressed as a linear first –order system while at the equilibrium point (where $f = 0$):

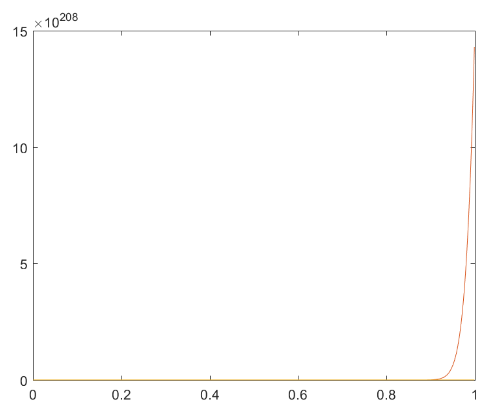
$$\begin{bmatrix} \dot{z} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} -\alpha_z & -\alpha_z\beta_z \\ 1 & 0 \end{bmatrix} \begin{bmatrix} z \\ y \end{bmatrix}$$

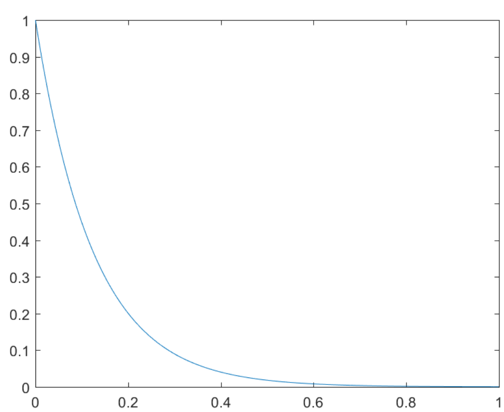
If the system is critically damped i.e. $\beta_z = \frac{\alpha_z}{4}$, the system will be asymptotically stable. For example , $\alpha_z = 24, \beta_z = 6$. Then $\begin{bmatrix} -\alpha_z & -\alpha_z\beta_z \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} -24 & -144 \\ 1 & 0 \end{bmatrix}$.

The eigenvalues of $\begin{bmatrix} -24 & -144 \\ 1 & 0 \end{bmatrix}$ is $\begin{bmatrix} -12 \\ -12 \end{bmatrix}$, where all eigenvalues are strictly negative. Thus the above linear first-order system is stable.

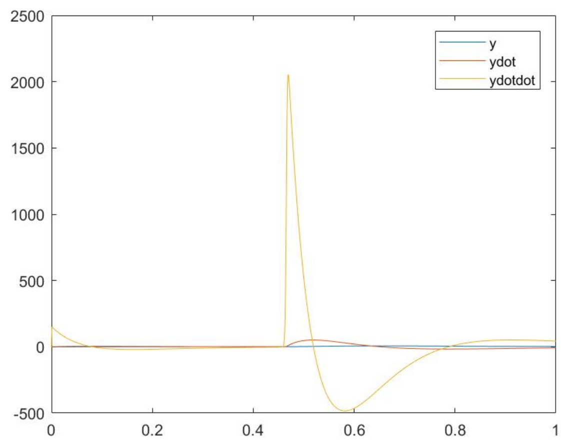
c)



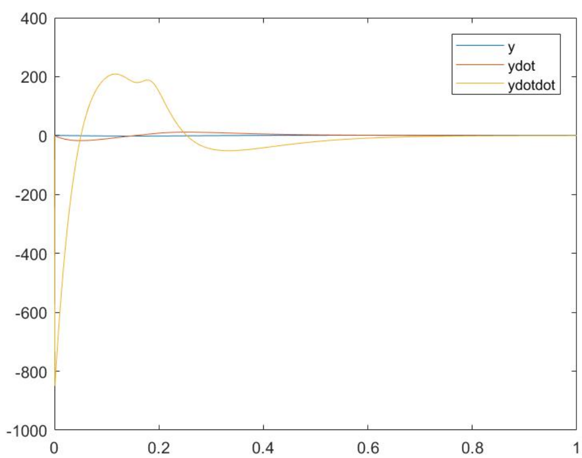




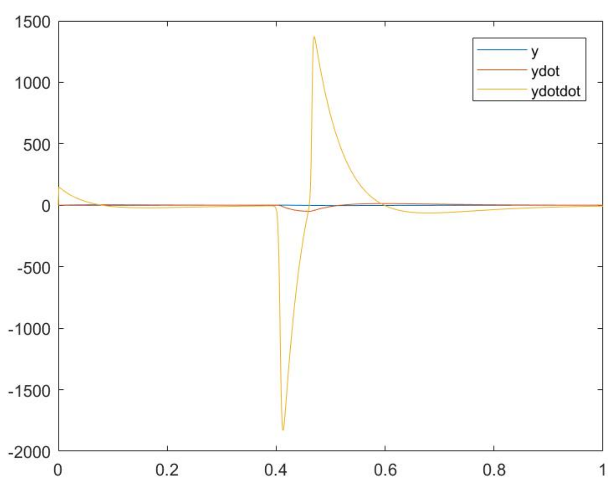
d) `w1=[0 0 0 0 1 1 1 100000 100000 100000];`



`W2=[-1000 -800 0 0 0 0 0 0 0 0];`



`W3=[0 0 0 0 0 0 -60000 0 0 0];`



e)

$$X = \begin{bmatrix} e^{-\frac{1}{2\sigma_1^2}(x-c_1)^2} \\ e^{-\frac{1}{2\sigma_2^2}(x-c_2)^2} \\ \cdot \\ \cdot \\ \cdot \\ e^{-\frac{1}{2\sigma_{10}^2}(x-c_{10})^2} \end{bmatrix} / \left(\sum_{i=1}^{10} e^{-\frac{1}{2\sigma_i^2}(x-c_i)^2}\right)$$

$$t = \dot{z} - \alpha_z(\beta_z(g-y)-z)$$

The regression solution:

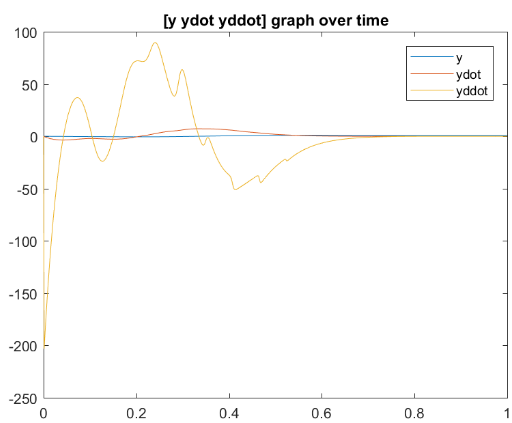
$$w = X \backslash t$$

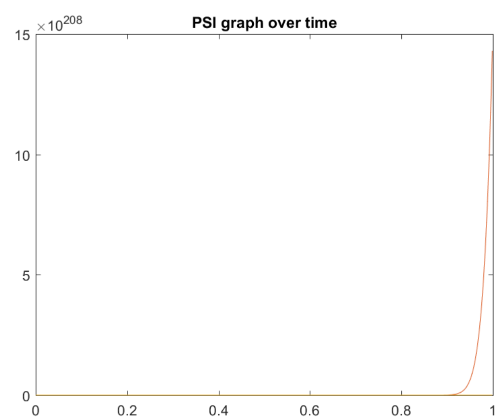
The regression solution is done using least square linear system solve in matlab.

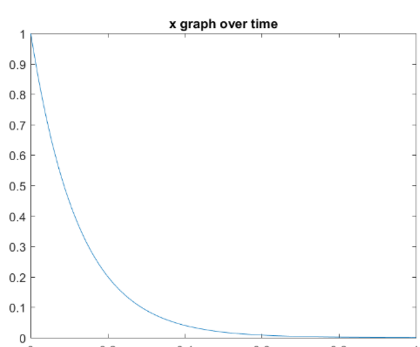
The weight vector w for this dataset:

$w = [-0.3531\ \ -1.0406\ \ -0.7929\ \ -0.3090\ \ 0.5479\ \ 1.0200\ \ 0.6567\ \ 0.2144\ \ -0.0172\ \ 0] * 1000$

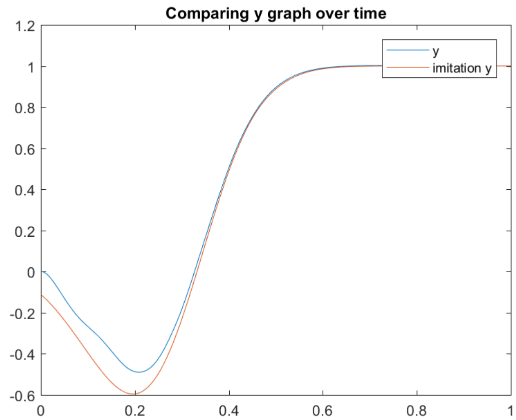
Graph of this weight vector:

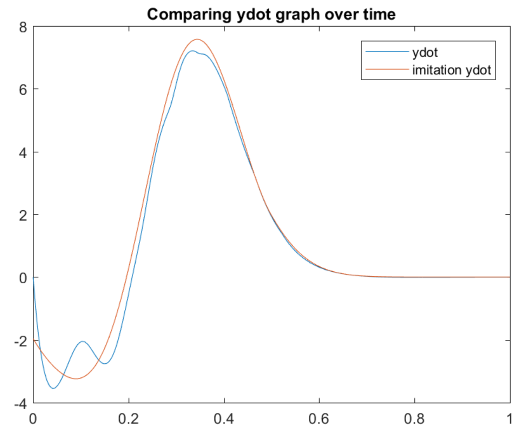


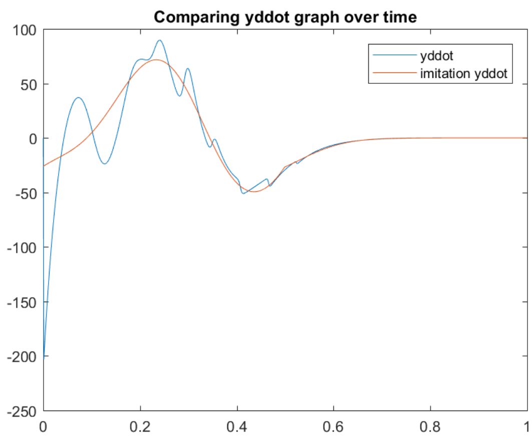




Comparing:







Comments:

The imitation was quite good in terms of y variable.