$$m := 1$$
$$l := 1 \qquad v_0 := 2 \cdot \sqrt{g \cdot l} \qquad \varphi_0 := \frac{80}{180}\,\pi \qquad a := l \qquad k := 0.2 \qquad \boxed{v_0} := 0 \qquad\qquad g := 9.80665$$

$$y := \begin{bmatrix} v_0 \\ \varphi_0 \end{bmatrix} \qquad w_0 := \sqrt{\frac{g}{l}}$$

$$D(t,y) := \begin{bmatrix} -w_0{}^2 \cdot y_1 \cdot 1 - 0 \cdot w_0{}^2 \cdot \sin(y_1) - k \cdot y_0 + a \cdot \sin(w_1 \cdot t) \\ y_0 \end{bmatrix} \qquad Z := \mathrm{rkfixed}(y, 0, 9.9, 2000, D) \qquad Z =$$

$$\left(Z^{\langle 2 \rangle}\right)_i$$
_____



$$\left(Z^{\langle 0 \rangle}\right)_i$$
_____

$$\left(Z^{\langle 2 \rangle}\right)_i$$
_____



$$\left(Z^{\langle 1 \rangle}\right)_i$$
_____

$$\begin{bmatrix} 0.102 \\ 0.102 \\ 0.102 \\ 0.102 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 4.885 \cdot 10^{-4} \\ 9.771 \cdot 10^{-4} \\ 0.001 \end{bmatrix}$$
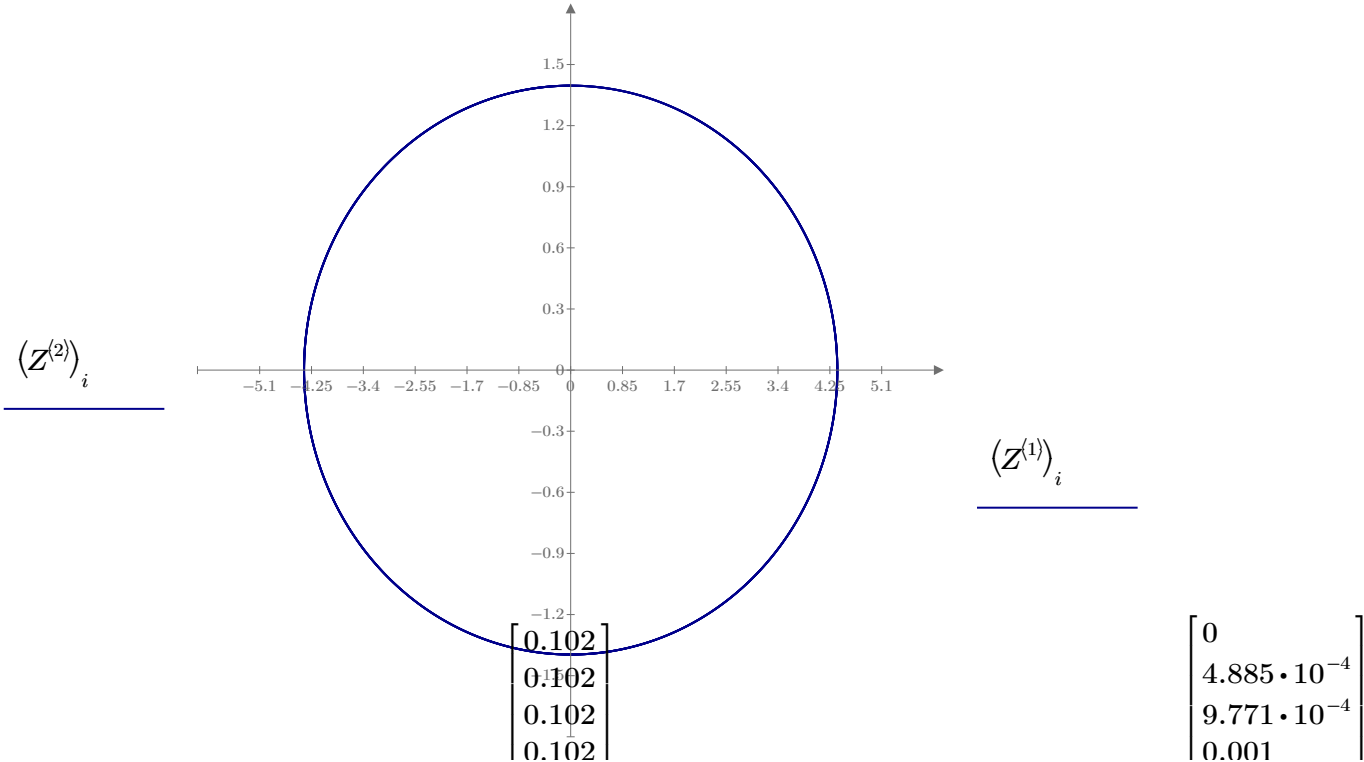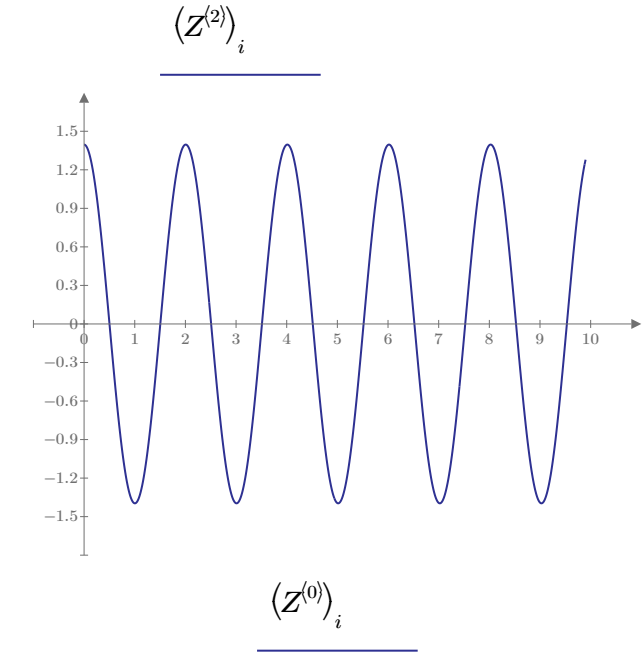
$$A := \frac{1}{\sqrt{\left(w_0{}^2 - w^2\right)^2 + 4\left(\delta^2 \cdot w^2\right)}} = \begin{bmatrix} 0.102 \\ 0.102 \\ 0.102 \\ 0.102 \\ 0.102 \\ 0.102 \\ 0.102 \\ 0.103 \\ 0.103 \\ \vdots \end{bmatrix}$$

$$\varphi := \operatorname{atan}\left(\frac{2 \cdot \delta \cdot w}{w_0{}^2 - w^2}\right) = \begin{bmatrix} 0.002 \\ 0.002 \\ 0.003 \\ 0.003 \\ 0.004 \\ 0.004 \\ 0.005 \\ 0.005 \\ \vdots \end{bmatrix}$$

$$g := 9.80665$$

$$v_0 := 2 \cdot \sqrt{g \cdot l} \qquad \varphi_0 := 0 \quad a := l \quad k := 0.2 \qquad v_0 := \frac{\pi}{2} \qquad y := \begin{bmatrix} v_0 \\ \varphi_0 \end{bmatrix} \qquad w_0 := \sqrt{\tfrac{g}{l}}$$
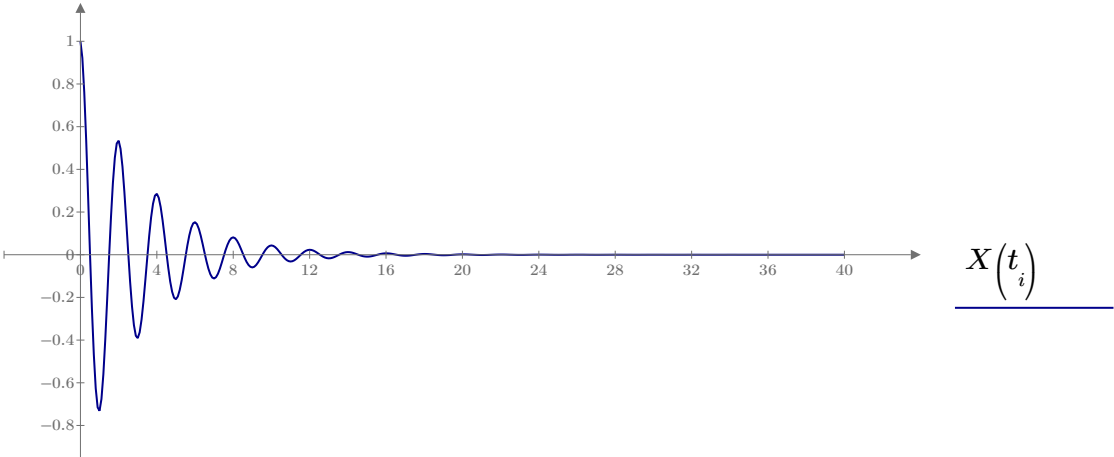
$$\begin{Vmatrix} w0 \leftarrow \sqrt{\dfrac{g}{l}} \\ h \leftarrow 0.025 \\ d \leftarrow 0.1 \\ w \leftarrow w0 \cdot 0.1 \\ v \leftarrow \dfrac{\pi}{24} \\ phi \leftarrow 0 \\ i \leftarrow 0 \\ m \leftarrow l \cdot \sin(phi) \\ \text{while } i < n \\ \quad \begin{Vmatrix} t \leftarrow h \cdot \left(a \cdot \sin(w \cdot i \cdot h) - w0^2 \cdot \sin(phi)\right) \\ phi \leftarrow phi + h \cdot v \\ v \leftarrow v + t \\ i \leftarrow i + 1 \\ \text{if } (l \cdot \sin(phi) > m) \\ \quad \begin{Vmatrix} m \leftarrow l \cdot \sin(phi) \end{Vmatrix} \end{Vmatrix} \\ m \end{Vmatrix} = 1$$

$$R(t, y) := \begin{bmatrix} \dfrac{-g}{l} \cdot y_1 \cdot 0 - 1 \cdot w_0 \cdot \sin(y_1) - k \cdot y_0 + a \cdot \sin(w \\ y_0 \end{bmatrix}$$

$$\left(A^{\langle i \rangle}\right)_j := \frac{A0}{m \cdot \sqrt{\left(w0^2 - w_j{}^2\right)^2 + 4\, b_i{}^2 \cdot w_j{}^2}}$$

$$t := 0, 0.1 .. 40 = \begin{bmatrix} 0 \\ \vdots \end{bmatrix}$$

$$d := 0.1 \qquad\qquad w0 := \sqrt{\dfrac{g}{l}} \qquad w := w0 \qquad f := 0 \qquad\qquad m := 1$$
$$l := 1$$

$$A0 := l \qquad b := d \cdot w0 \qquad\qquad X(t) := A0 \cdot e^{-b \cdot t} \cdot \cos(w \cdot t + f)$$



$$X\left(t_i\right)$$

$n := 1000$

$m := 3 \qquad step := \dfrac{m}{n}$

$k := 0, step..m = \begin{bmatrix} 0 \\ 0.003 \\ 0.006 \\ \vdots \end{bmatrix}$

$z(t) := 3 \cdot \dfrac{t}{m}$

$z(k) = \begin{bmatrix} 0 \\ 0.003 \\ 0.006 \\ \vdots \end{bmatrix}$

$w := w0 \cdot k = \begin{bmatrix} 0 \\ 0.009 \\ 0.019 \\ \vdots \end{bmatrix}$

$d := 0, 0.01..10 = \begin{bmatrix} 0 \\ \vdots \end{bmatrix}$

$b := w0 \cdot d$

$A_1 := \begin{Vmatrix} j \leftarrow 0 \\ \text{while } j \leq n \\ \begin{Vmatrix} (A)_j \leftarrow \dfrac{A0}{m \cdot \sqrt{\left(w0^2 - w_j^2\right)^2 + 4 \; b_{30}^2 \cdot w_j^2}} \\ j \leftarrow j+1 \end{Vmatrix} \\ A \end{Vmatrix}$

$A_2 := \begin{Vmatrix} j \leftarrow 0 \\ \text{while } j \leq n \\ \begin{Vmatrix} (A)_j \leftarrow \dfrac{A0}{m \cdot \sqrt{\left(w0^2 - w_j^2\right)^2 + 4 \; b_{30}^2 \cdot w_j^2}} \\ j \leftarrow j+1 \end{Vmatrix} \\ A \end{Vmatrix}$

$A_5 := \begin{Vmatrix} j \leftarrow 0 \\ \text{while } j \leq n \\ \begin{Vmatrix} (A)_j \leftarrow \dfrac{A0}{m \cdot \sqrt{\left(w0^2 - w_j^2\right)^2 + 4 \; b_{15}^2 \cdot w_j^2}} \\ j \leftarrow j+1 \end{Vmatrix} \\ A \end{Vmatrix}$

$A_6 := \begin{Vmatrix} j \leftarrow 0 \\ \text{while } j \leq n \\ \begin{Vmatrix} (A)_j \leftarrow \dfrac{A0}{m \cdot \sqrt{\left(w0^2 - w_j^2\right)^2 + 4 \; b_{20}^2 \cdot w_j^2}} \\ j \leftarrow j+1 \end{Vmatrix} \\ A \end{Vmatrix}$

$A_9 := \begin{Vmatrix} j \leftarrow 0 \\ \text{while } j \leq n \\ \begin{Vmatrix} (A)_j \leftarrow \dfrac{A0}{m \cdot \sqrt{\left(w0^2 - w_j^2\right)^2 + 4 \; b_{50}^2 \cdot w_j^2}} \\ j \leftarrow j+1 \end{Vmatrix} \end{Vmatrix}$

$A_{10} := \begin{Vmatrix} j \leftarrow 0 \\ \text{while } j \leq n \\ \begin{Vmatrix} (A)_j \leftarrow \dfrac{A0}{m \cdot \sqrt{\left(w0^2 - w_j^2\right)^2 + 4 \; b_{100}^2 \cdot w_j^2}} \\ j \leftarrow j+1 \end{Vmatrix} \end{Vmatrix}$

$$\frac{w_i}{w0}$$



$A_{3_i}$

$A_{4_i}$

$A_{5_i}$

$A_{6_i}$

$A_{7_i}$

$A_{8_i}$

$A_{9_i}$

$A_{10_i}$

$A_{11_i}$

$A_{12_i}$