## Plot

$$PPlot(xy(1), T) := \left| \begin{array}{l} [\, n := \text{length}(T) \;\; XY := \text{matrix}(n, 2) \;\; k := [1..n] \;\; c := [1..2] \,] \\ \text{eval}\left( \left( \begin{array}{l} XY_{k,c} := \text{try} \\ \qquad xy(T_k)_c \\ \quad \text{on error} \\ \qquad XY_{\max([1\ k-1]),c} \end{array} \right)_{[2..(n-1)],c} \right) \end{array} \right.$$

$$PPlot(x(1), y(1), T) := \left| \begin{array}{l} xy(t\#) := [\, x(t\#)\ y(t\#) \,] \\ PPlot(xy(t\#), T) \end{array} \right.$$

$$Id(t) := |\, t$$

$$Plot(f(1), T) := \left| \begin{array}{l} \text{if } (T_1 < x) \wedge (x < T_{\text{length}(T)}) \\ \quad f(x) \\ \text{else} \\ \quad \text{"not defined"} \end{array} \right.$$

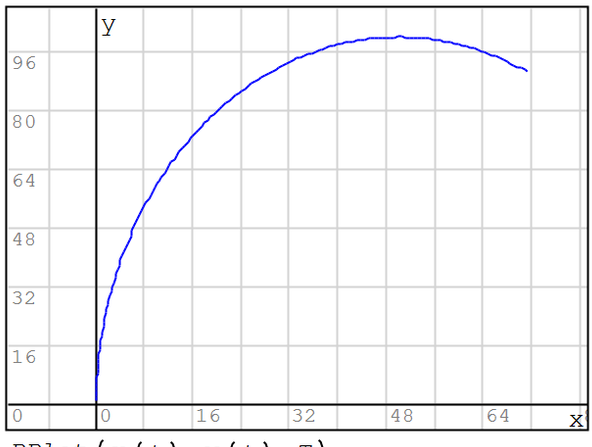
$$NDiff(f(1), t) := \left| \frac{f(t + h_{NDiff}) - f(t)}{h_{NDiff}} \right. \qquad h_{NDiff} := 10^{-5}$$

## k

$V := 20$ $a := 50$ $b := 100$ $T := [0, 0.05..8]$ $\text{length}(T) = 161$

$$r := \sqrt{\frac{a^2 + b^2}{2}} = 79.0569 \qquad \omega := \frac{V}{r} = 0.253$$

$$\begin{cases} x(t) := a - a \cdot \sin\left(\omega \cdot t + \frac{\pi}{2}\right) \\ y(t) := 100 \cdot \sin(\omega \cdot t) \end{cases}$$




$PPlot(x(t), y(t), T)$

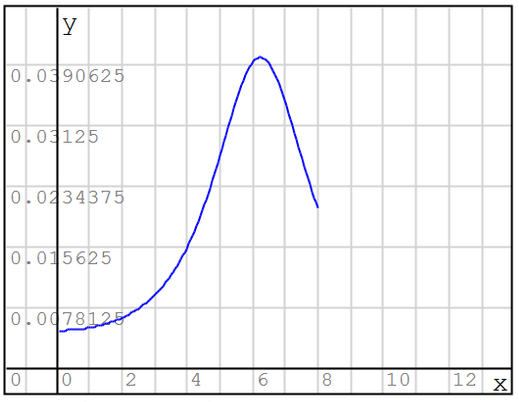
Derivatives & slopes

$$x'(t) := \frac{d}{dt} x(t) \qquad y'(t) := \frac{d}{dt} y(t) \qquad m(t) := \frac{y'(t)}{x'(t)}$$

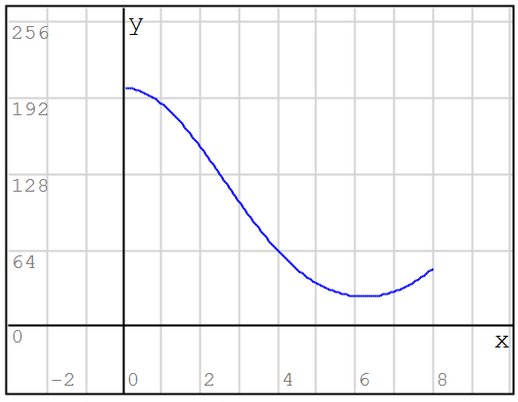
$$x''(t) := \frac{d}{dt} x'(t) \qquad y''(t) := \frac{d}{dt} y'(t) \qquad slope(t) := \text{atan}(m(t))$$

Curvature & Radious of curvature

$$c(t) := \frac{|x'(t) \cdot y''(t) - y'(t) \cdot x''(t)|}{\sqrt{\left(x'(t)^2 + y'(t)^2\right)^3}} \qquad R_c(t) := \frac{1}{c(t)}$$




$Plot(c(t), T)$

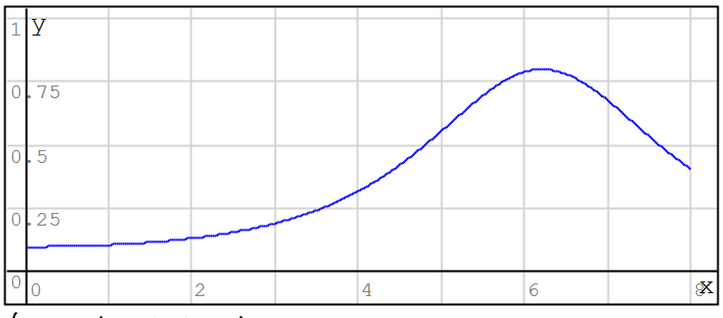



$Plot(R_c(t), T)$

$$\psi'(t) := \left(\frac{V}{R_c(t)}\right)$$

velocità di imbardata

in rad/sec per calcoli successivi




$Plot(\psi'(t), T)$

$$m := 200 \qquad \omega_r := \frac{V}{0.32} = 62.5$$

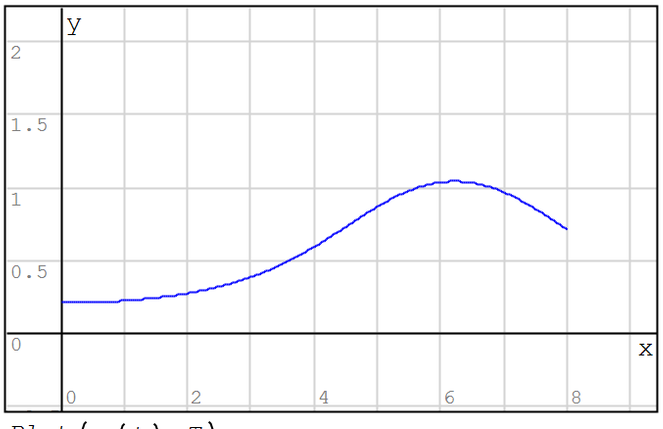
$$h_g := 0.6 \qquad I_w := 1.2$$

$$\varphi_{id}(t) := \left(\operatorname{atan}\left(\frac{V^2}{9.806 \cdot R_c(t)}\right)\right)$$

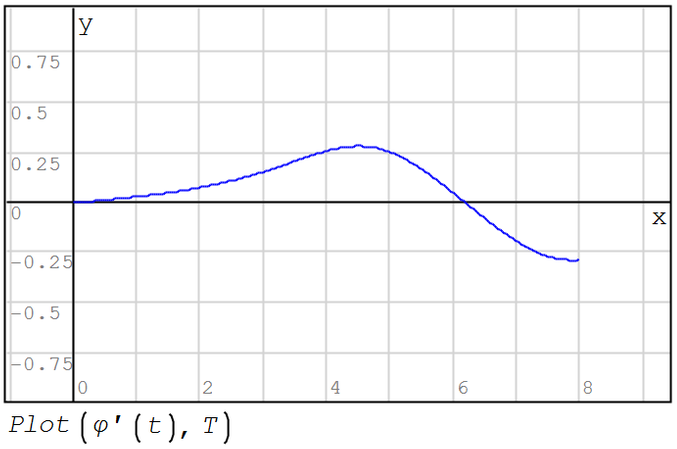
$$\varphi(t) := \varphi_{id}(t) + \left(\frac{I_w \cdot \omega_r \cdot \psi'(t) \cdot \cos\left(\varphi_{id}(t)\right)}{h_g \cdot \sqrt{(m \cdot 9.806)^2 + \left(m \cdot R_c(t) \cdot (\psi'(t))^2\right)^2}}\right)$$

$$\varphi'(t) := NDiff(\varphi(t), t) \qquad \varphi'(t) := \frac{d}{d\,t}\varphi(t)$$

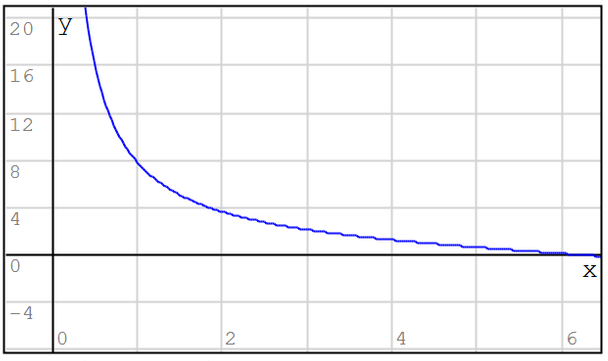
velocità di rollio



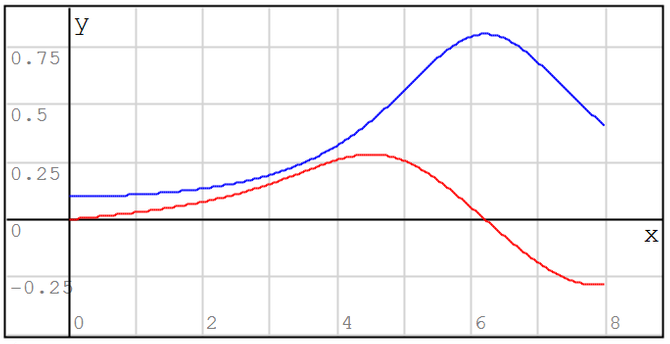

$Plot(\varphi(t), T)$




$Plot(\varphi'(t), T)$




$Plot(m(t), T)$

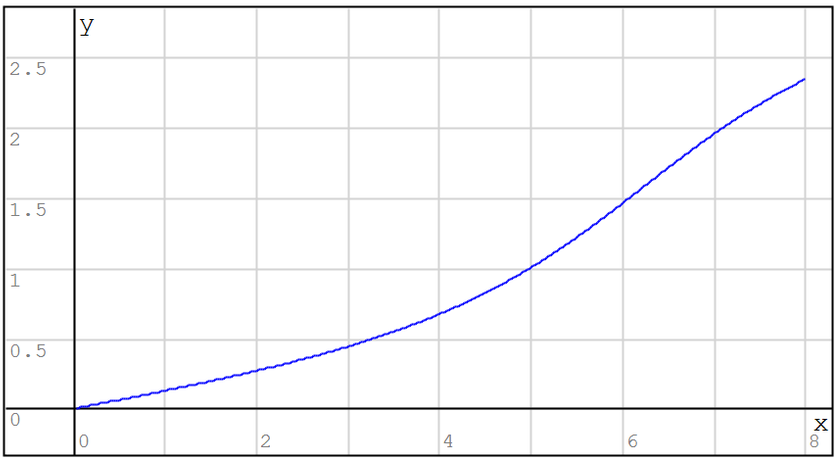



$Plot(\psi'(t), T)$
$Plot(\varphi'(t), T)$

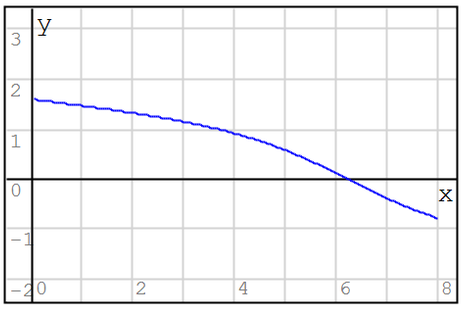
in rad/sec per calcoli successivi

$$\psi(t) := \left| \frac{\pi}{2} - \operatorname{atan}(m(t)) \right|$$

andamento dell'angolo tra i due sistemi di riferimento (fisso e mobile) rispetto a t



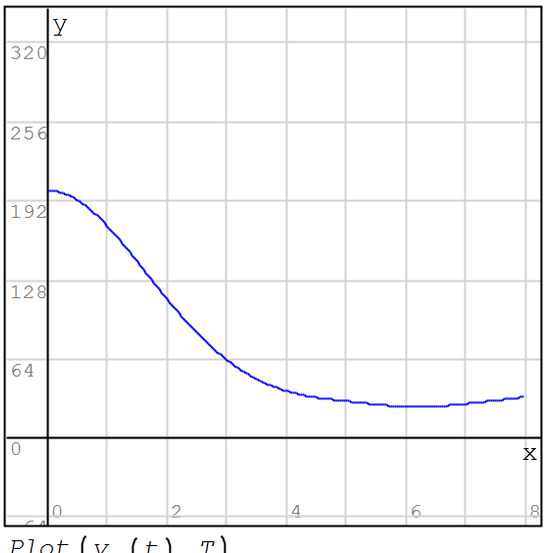

$Plot(\psi(t), T)$




$Plot(slope(t), T)$

coordinate traccia di mozzi nel sistema solidalle alla motocicletta

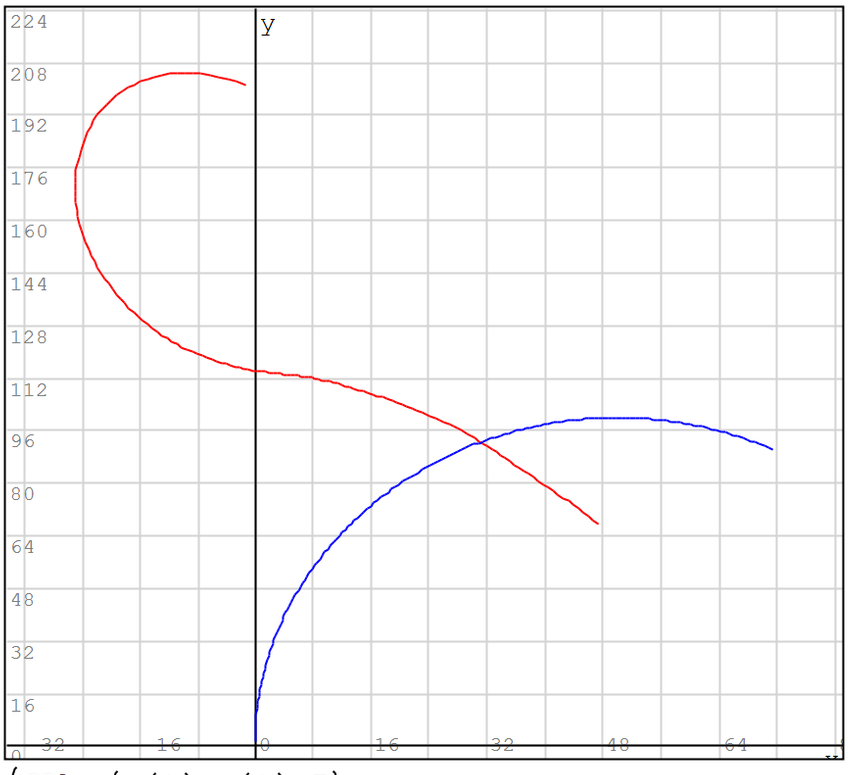
$$\begin{cases} x_m(t) := 0 \\ y_m(t) := \dfrac{\psi'(t) \cdot V}{(\psi'(t))^2 + (\varphi'(t))^2} \end{cases}$$




$Plot(y_m(t), T)$

$$\begin{cases} x_t(t) := 0 \\ y_t(t) := \dfrac{V}{\psi'(t)} \end{cases}$$

$$xy_M(t) := \begin{bmatrix} x(t) \\ y(t) \end{bmatrix} + \begin{bmatrix} \cos(\psi(t)) & -\sin(\psi(t)) \\ \sin(\psi(t)) & \cos(\psi(t)) \end{bmatrix} \cdot \begin{bmatrix} x_m(t) \\ y_m(t) \end{bmatrix}$$




$$\begin{cases} PPlot(x(t), y(t), T) \\ PPlot(xy_M(t), T) \end{cases}$$

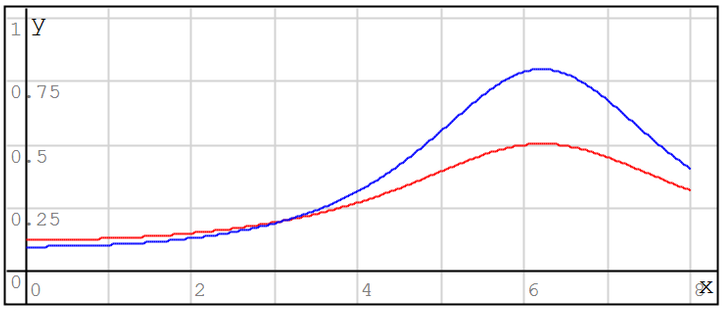
---

Notes

1. You define twice ψ(t), check your integral

$$\psi(t) := \left(\frac{\pi}{2} - \operatorname{atan}(m(t))\right)$$

$$yy'(t) := \frac{d}{dt}\psi(t)$$




$$\begin{cases} Plot(\psi'(t), T) \\ Plot(yy'(t), T) \end{cases}$$

2. $$\begin{cases} x_M(t) := \left| xy_M(t) \right._1 \\ y_M(t) := \left| xy_M(t) \right._2 \end{cases}$$ works: $t_o := 5$ $$\begin{cases} x_M(t_o) \\ y_M(t_o) \end{cases} = \begin{cases} 9.8243 \\ 111.223 \end{cases}$$

But can't be used in $PPlot(x_M(t), y_M(t), T)$

*Alvaro*