$T := 1.5$ Tempo di azionamento [s]

$T_{max} := 2 \cdot T = 3$ Tempo totale di simulazione

$h_{max} := 3$ Spostamento angolare da compiere [rad]

$\Delta t := 0.005$ $D := 10$ $E := -15$ $F := 6$

$t := 0, \Delta t .. T_{max}$

Legge di moto del vincolo mobile

$$y(t) := \begin{cases} h_{max} \cdot \left[D \cdot \left(\frac{t}{T} \right)^3 + E \cdot \left(\frac{t}{T} \right)^4 + F \cdot \left(\frac{t}{T} \right)^5 \right] & \text{if } 0 \le t \le T \\ h_{max} & \text{otherwise} \end{cases}$$

$$y'(t) := \begin{cases} \frac{h_{max}}{T} \cdot \left[3 \cdot D \cdot \left(\frac{t}{T} \right)^2 + 4 \cdot E \cdot \left(\frac{t}{T} \right)^3 + 5 \cdot F \cdot \left(\frac{t}{T} \right)^4 \right] & \text{if } 0 \le t \le T \\ 0 & \text{otherwise} \end{cases}$$

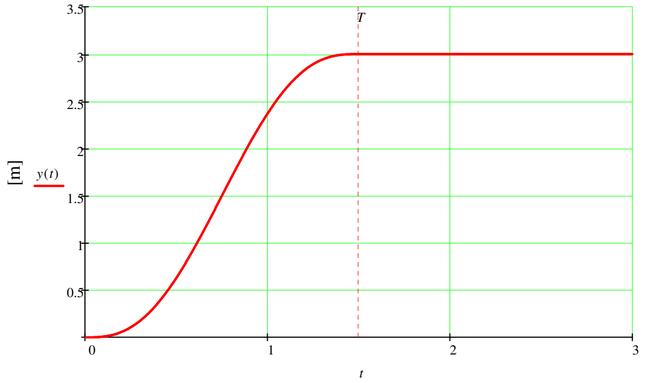
$$y''(t) := \begin{cases} \frac{h_{max}}{T^2} \cdot \left[6 \cdot D \cdot \left(\frac{t}{T} \right) + 12 \cdot E \cdot \left(\frac{t}{T} \right)^2 + 20 \cdot F \cdot \left(\frac{t}{T} \right)^3 \right] & \text{if } 0 \le t \le T \\ 0 & \text{otherwise} \end{cases}$$

$y(0) = 0$ $y(T) = 3$

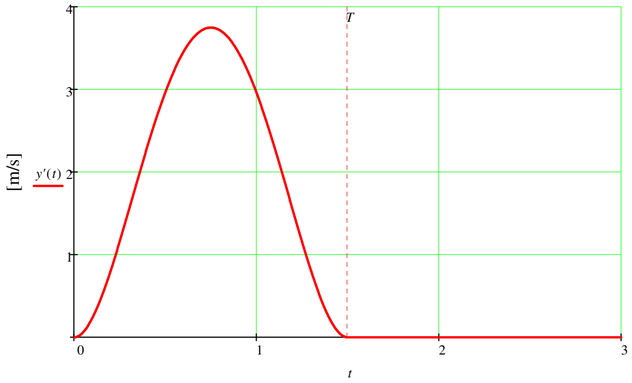
$y'(0) = 0$ $y'(T) = 0$

$y''(0) = 0$ $y''(T) = 0$

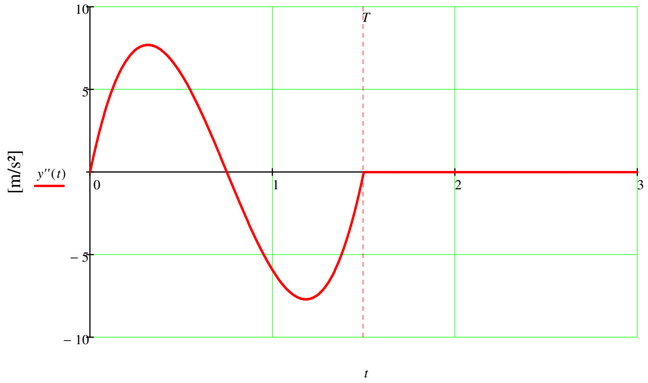
Spostamento imposto



Velocità imposta



Accelerazione imposta



$m := 20$ Massa [kg]

$k := 8000$ Rigidezza [N/m]

$c := 100$ Costante di smorzamento [Ns/m]

$\omega := \sqrt{\frac{k}{m}} = 20$ Pulsazione propria [rad/s]

$f := \frac{\omega}{2 \cdot \pi} = 3.183$ Frequenza propria [Hz]

$\tau := \frac{1}{f} = 0.314$ Periodo proprio [s]

$c_{crit} := 2 \cdot m \cdot \omega = 800$ Smorzamento critico [Nms/rad]

$\xi := \frac{c}{c_{crit}} = 0.125$ $\xi = 12.5 \cdot \%$ Fattore di smorzamento

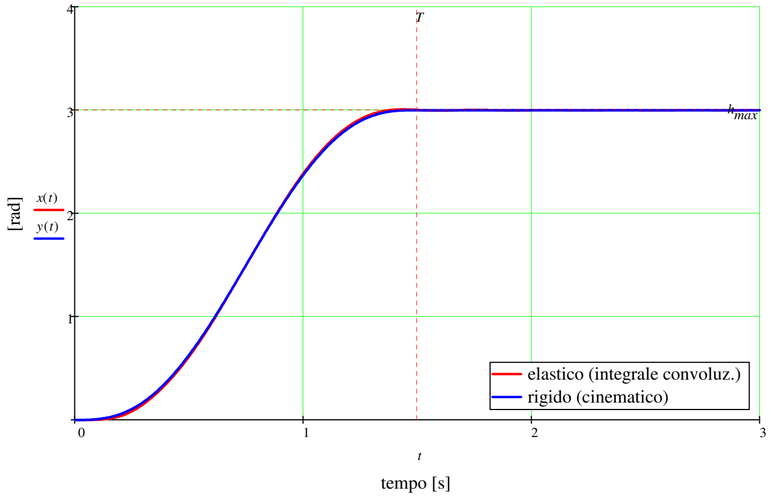
$\omega_s := \omega \cdot \sqrt{1 - \xi^2} = 19.843$ Pulsazione propria smorzata [rad/s] $\sqrt{1 - \xi^2} = 0.992$ $\xi^2 = 0.016$

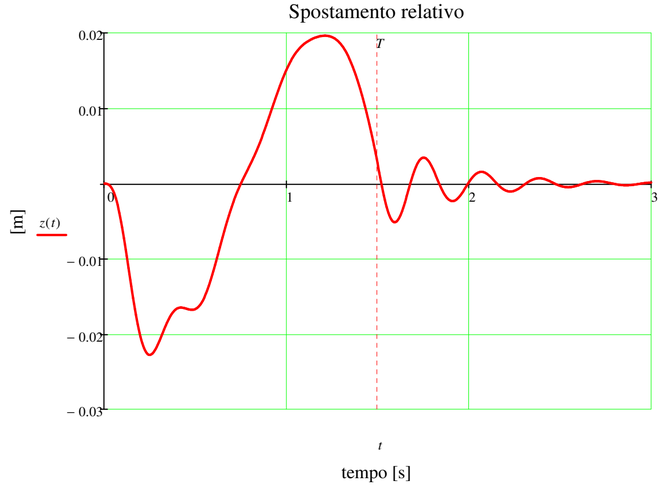
$f_s := \frac{\omega_s}{2 \cdot \pi} = 3.158$ Frequenza propria smorzata [Hz]

$z(t) := \frac{-1}{\omega_s} \cdot \int_0^t y''(\tau) \cdot e^{-\xi \cdot \omega \cdot (t-\tau)} \cdot \sin\left[\omega_s \cdot (t - \tau)\right] d\tau$ Integrale di convoluzione (calcola lo spostamento relativo)

$x(t) := z(t) + y(t)$

$t := 0, \Delta t .. T_{max}$





Calcolo mediante integrazione numerica (Runge Kutta)

$ORIGIN := 1$

$ACCEL(z, z', t) := -\left(2 \cdot \xi \cdot \omega \cdot z' + \omega^2 \cdot z + y''(t)\right)$

$EQMOTO(t, u) := \begin{pmatrix} u_2 \\ ACCEL\left(u_1, u_2, t\right) \end{pmatrix}$

$u := \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ $\Delta t_{cons} := \frac{1}{20} \cdot T = 0.075$

$$N_{pti} := \frac{T_{max}}{\Delta t} \qquad N_{pti} = 600$$

$$RIS := rkfixed(u, 0, T_{max}, N_{pti}, EQMOTO)$$

$$tempo := RIS^{\langle 1 \rangle}$$

$$Z := RIS^{\langle 2 \rangle}$$

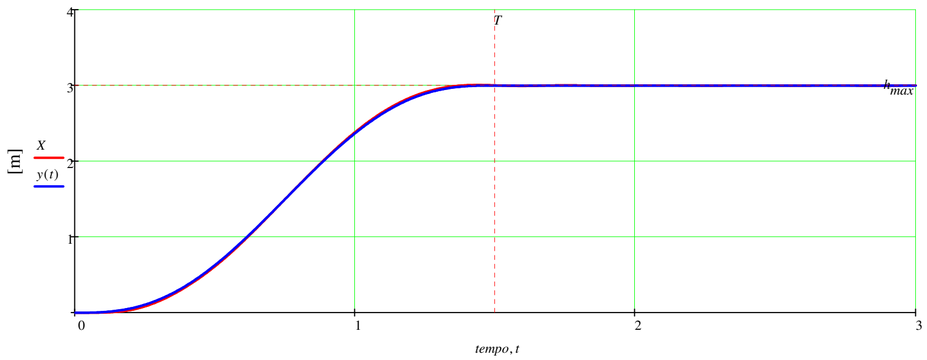
$$Z' := RIS^{\langle 3 \rangle}$$

$$\overrightarrow{Z'' := ACCEL(Z, Z', tempo)}$$

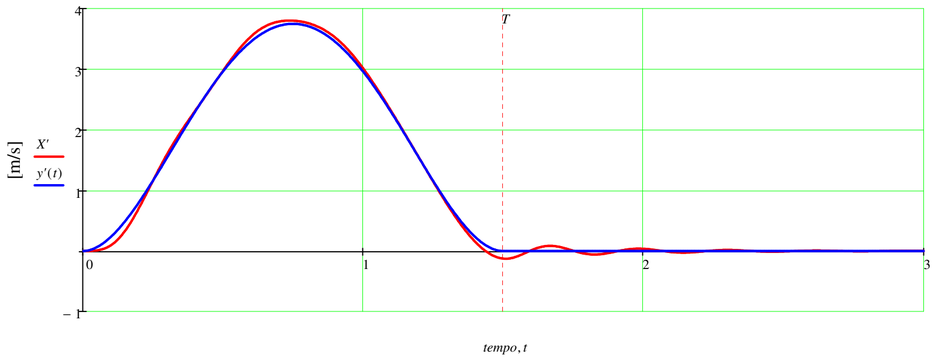
$$\overrightarrow{X := (Z + y(tempo))}$$

$$\overrightarrow{X' := (Z' + y'(tempo))}$$

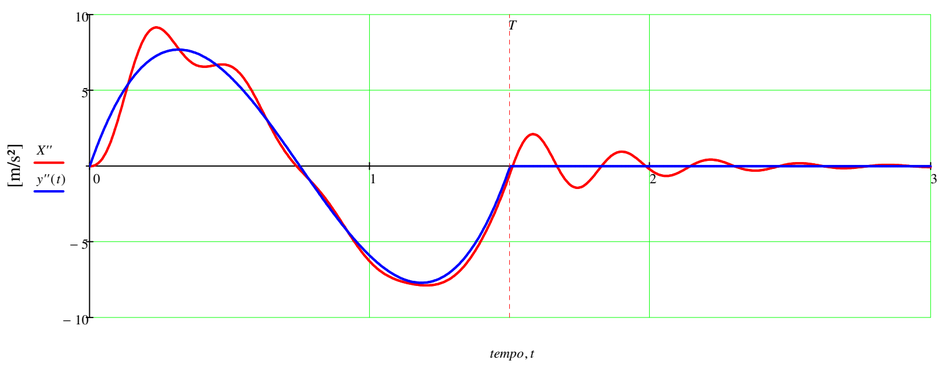
$$\overrightarrow{X'' := (Z'' + y''(tempo))}$$



tempo [s]

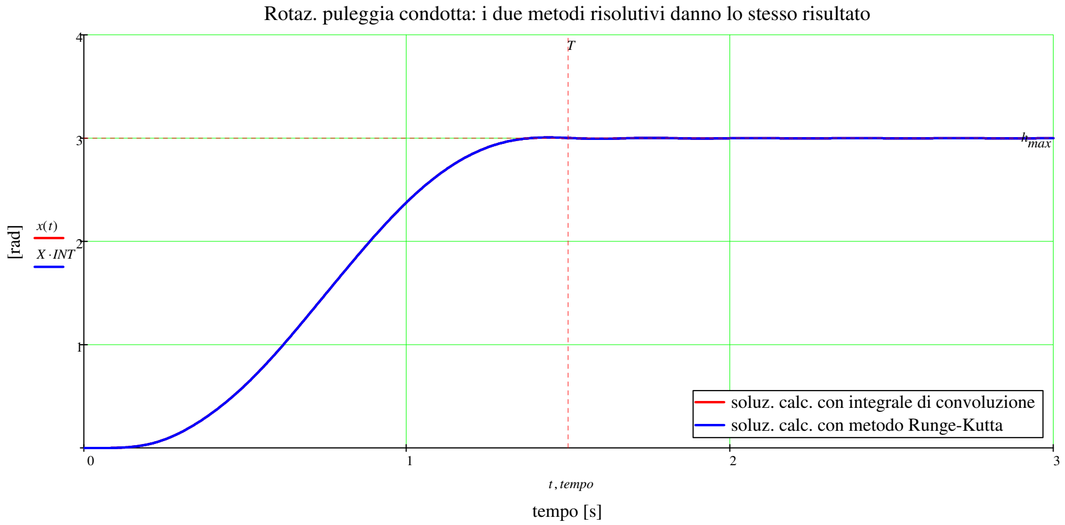


tempo [s]



tempo [s]

$INT := 1$


Rotaz. puleggia condotta: i due metodi risolutivi danno lo stesso risultato
T
h_{max}
[rad]
x(t)
X · INT
soluz. calc. con integrale di convoluzione
soluz. calc. con metodo Runge-Kutta
0
1
2
3
4
t , tempo
tempo [s]