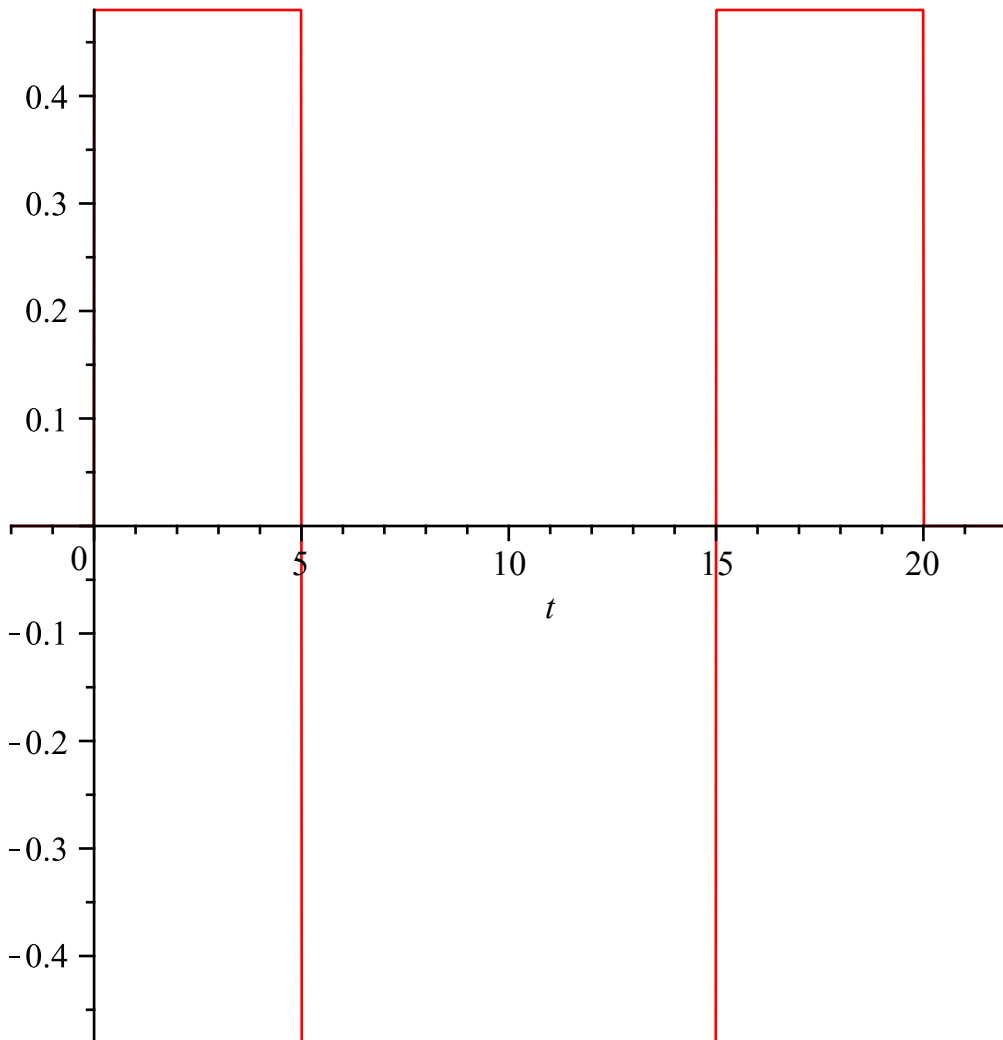


> restart

PROBLEMA DE CINEMÁTICA DE UN ELEVADOR MODERNO

> $S(t) := \frac{48}{100} \cdot \text{Heaviside}(t) - \frac{96}{100} \cdot \text{Heaviside}(t - b) + \frac{96}{100} \cdot \text{Heaviside}(t - 3 \cdot b) - \frac{48}{100} \cdot \text{Heaviside}(t - 4 \cdot b); \text{plot}(\text{subs}(b = 5, S(t)), t = -2 .. 22);$

$$S(t) := \frac{12}{25} \text{Heaviside}(t) - \frac{24}{25} \text{Heaviside}(t - b) + \frac{24}{25} \text{Heaviside}(t - 3b) - \frac{12}{25} \text{Heaviside}(t - 4b)$$



> Ecuacion := diff(y(t), t\$3) = S(t);

$$\text{Ecuacion} := \frac{d^3}{dt^3} y(t) = \frac{12}{25} \text{Heaviside}(t) - \frac{24}{25} \text{Heaviside}(t - b) + \frac{24}{25} \text{Heaviside}(t - 3b) - \frac{12}{25} \text{Heaviside}(t - 4b) \quad (1)$$

> CondicionesIniciales := y(0) = 0, D(y)(0) = 0, D(D(y))(0) = 0;

$$\text{CondicionesIniciales} := y(0) = 0, D(y)(0) = 0, D^{(2)}(y)(0) = 0 \quad (2)$$

> with(inttrans) :

> LaplaceEcuacion := subs(CondicionesIniciales, laplace(Ecuacion, t, s));

$$\text{LaplaceEcuacion} := s^3 \text{laplace}(y(t), t, s) = \frac{12}{25s} - \frac{24}{25} \text{laplace}(\text{Heaviside}(t-b), t, s) \\ + \frac{24}{25} \text{laplace}(\text{Heaviside}(t-3b), t, s) - \frac{12}{25} \text{laplace}(\text{Heaviside}(t-4b), t, s) \quad (3)$$

> $\text{LaplaceSolucion} := \text{isolate}(\text{LaplaceEcuacion}, \text{laplace}(y(t), t, s));$

$$\text{LaplaceSolucion} := \text{laplace}(y(t), t, s) = \frac{1}{s^3} \left(\frac{12}{25s} - \frac{24}{25} \text{laplace}(\text{Heaviside}(t-b), t, s) \right. \\ \left. + \frac{24}{25} \text{laplace}(\text{Heaviside}(t-3b), t, s) - \frac{12}{25} \text{laplace}(\text{Heaviside}(t-4b), t, s) \right) \quad (4)$$

> $\text{SolucionParticular} := \text{invlaplace}(\text{LaplaceSolucion}, s, t);$

$$\text{SolucionParticular} := y(t) = \frac{2}{25} t^3 - \frac{24}{25} \text{Heaviside}(-b) b^3 - \frac{2}{25} \text{Heaviside}(t-4b) (t-4b)^3 \\ + \frac{4}{25} \text{Heaviside}(t-3b) (t-3b)^3 - \frac{4}{25} \text{Heaviside}(t-b) (t-b)^3 \quad (5)$$

> $\text{CuartoTiempoFinal} := \text{solve}(\text{subs}(\text{Heaviside}(-b) = 0, \text{Heaviside}(b) = 1, \text{isolate}(\text{subs}(t=4 \cdot b, \text{rhs}(\text{SolucionParticular}) = 225), b)), b) : \text{evalf}(\%, 3)$

$$6.18, -3.09 + 5.34 I, -3.09 - 5.34 I \quad (6)$$

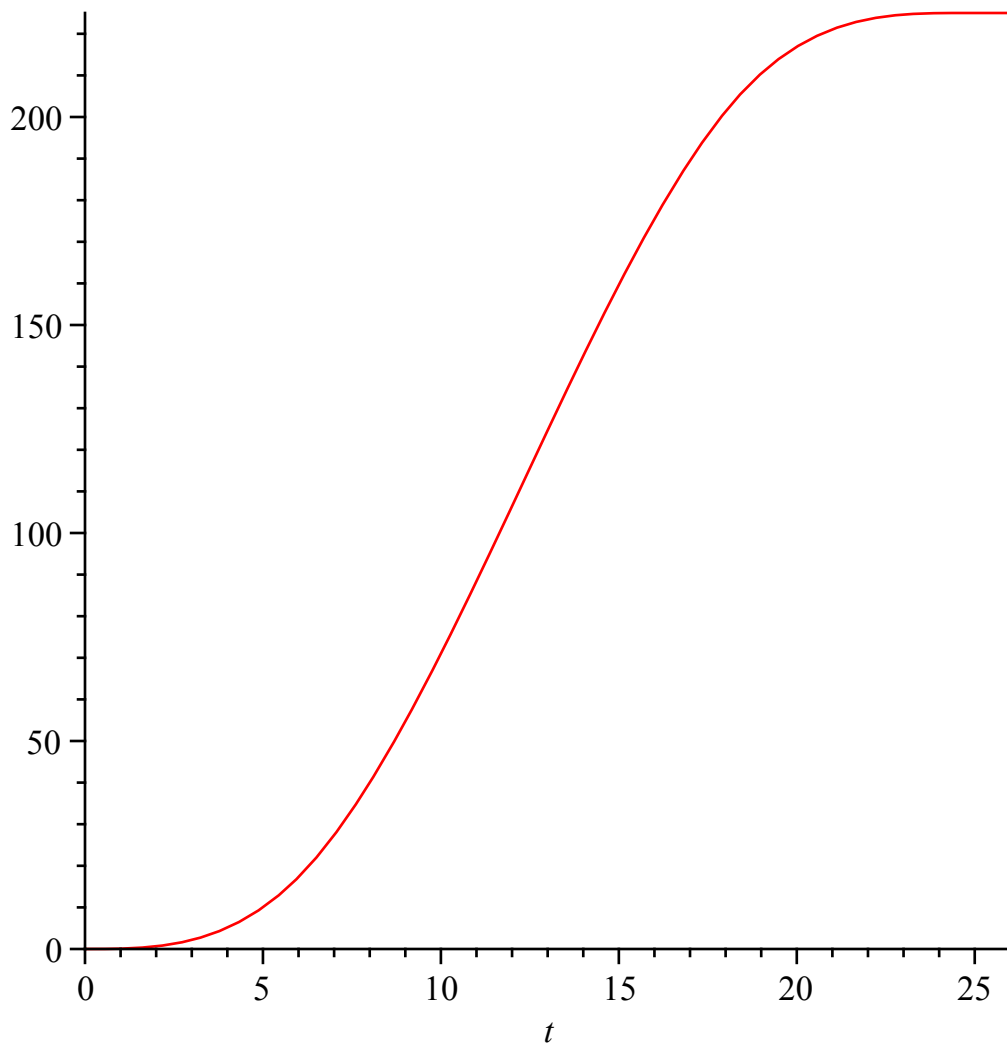
> $\text{TiempoFinal} := 4 \cdot \text{CuartoTiempoFinal}_1 : \text{evalf}(\%, 4);$

$$24.66 \quad (7)$$

> $\text{recorrido} := \text{subs}(b = \text{CuartoTiempoFinal}_1, \text{SolucionParticular});$

$$\text{recorrido} := y(t) = \frac{2}{25} t^3 - 225 \text{Heaviside}\left(-\frac{5}{2} 15^{1/3}\right) - \frac{2}{25} \text{Heaviside}(t - 10 15^{1/3}) (t - 10 15^{1/3})^3 \\ + \frac{4}{25} \text{Heaviside}\left(t - \frac{15}{2} 15^{1/3}\right) \left(t - \frac{15}{2} 15^{1/3}\right)^3 - \frac{4}{25} \text{Heaviside}\left(t - \frac{5}{2} 15^{1/3}\right) \left(t - \frac{5}{2} 15^{1/3}\right)^3 \quad (8)$$

> $\text{plot}(\text{rhs}(\text{recorrido}), t = 0 .. 26);$



> $RecorridoMaximo := subs(t = 4 \cdot CuartoTiempoFinal_1, rhs(recorrido)) : evalf(\%, 4)$
 225. (9)

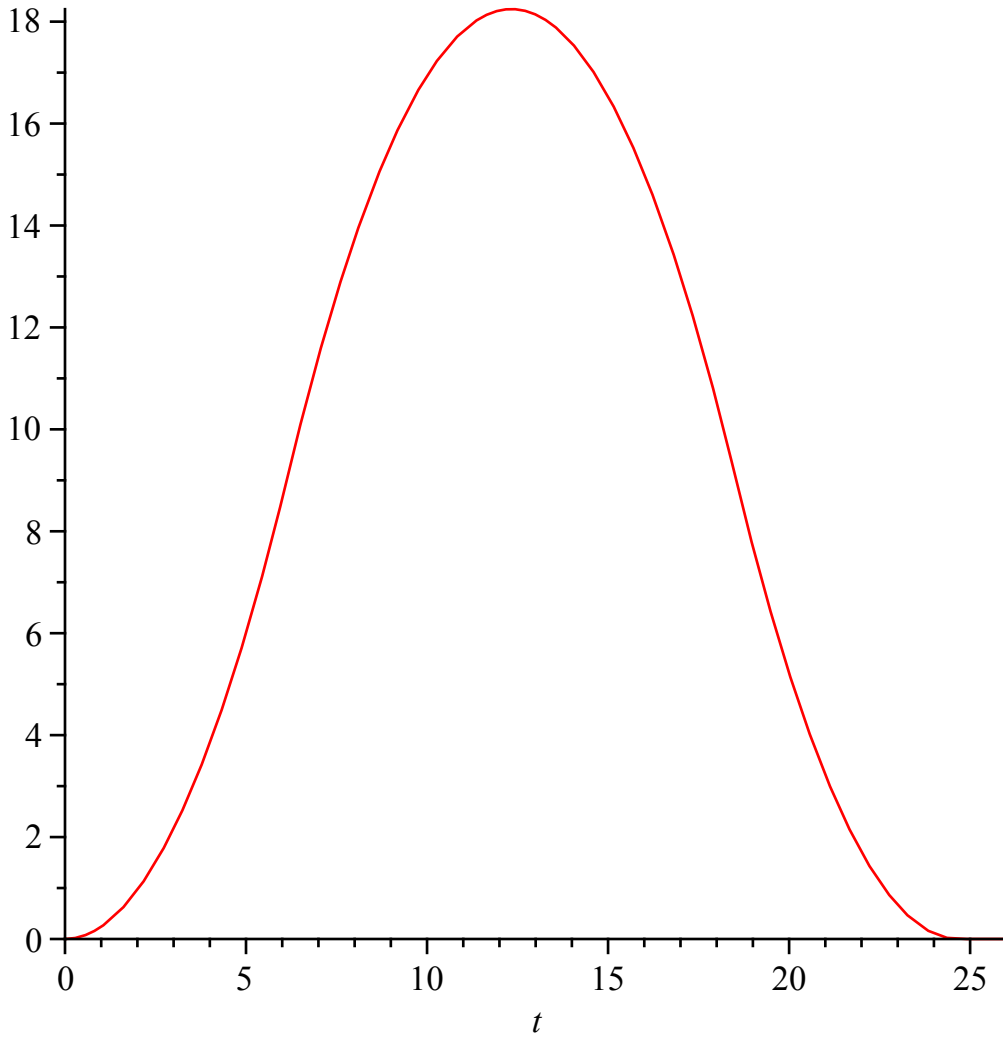
> $velocidad := subs(b = CuartoTiempoFinal_1, diff(SolucionParticular, t))$
 $velocidad := \frac{d}{dt} y(t) = \frac{6}{25} t^2 - \frac{2}{25} \text{Dirac}(t - 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})^3 - \frac{6}{25} \text{Heaviside}(t$ (10)

$$- 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})^2 + \frac{4}{25} \text{Dirac}\left(t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)^3$$

$$+ \frac{12}{25} \text{Heaviside}\left(t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)^2 - \frac{4}{25} \text{Dirac}\left(t - \frac{5}{2} \cdot 15^{1/3}\right) \left(t - \frac{5}{2} \cdot 15^{1/3}\right)^3$$

$$- \frac{12}{25} \text{Heaviside}\left(t - \frac{5}{2} \cdot 15^{1/3}\right) \left(t - \frac{5}{2} \cdot 15^{1/3}\right)^2$$

> $plot(rhs(velocidad), t = 0..26)$



> $VelocidadMáxima := subs(t = 2 \cdot CuartoTiempoFinal_1, rhs(velocidad)) : evalf(\%, 4)$ (11)

18.25

> $aceleracion := subs(b = CuartoTiempoFinal_1, diff(SolucionParticular, t\$2))$

$aceleracion := \frac{d^2}{dt^2} y(t) = \frac{12}{25} t - \frac{2}{25} \text{Dirac}(1, t - 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})^3 - \frac{12}{25} \text{Dirac}(t$ (12)

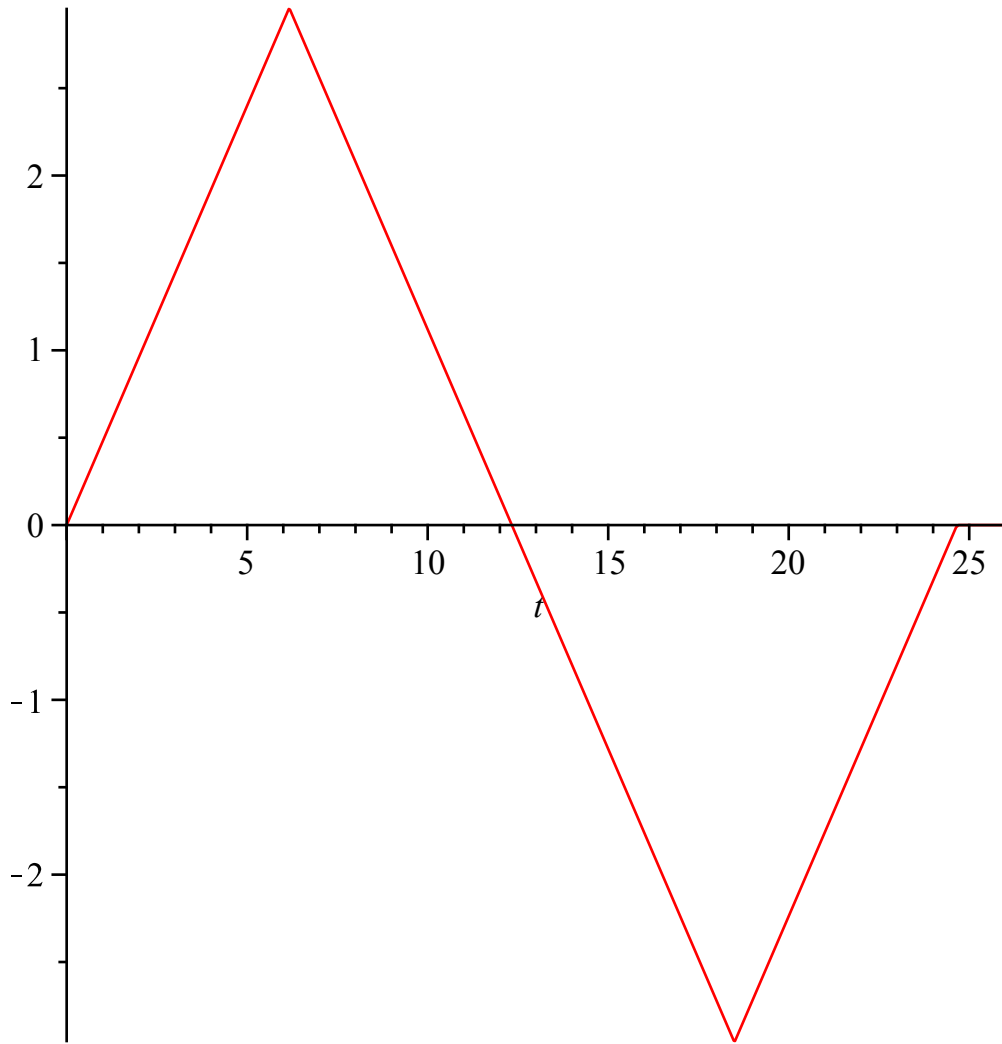
$$- 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})^2 - \frac{12}{25} \text{Heaviside}(t - 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})$$

$$+ \frac{4}{25} \text{Dirac}\left(1, t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)^3 + \frac{24}{25} \text{Dirac}\left(t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)^2$$

$$+ \frac{24}{25} \text{Heaviside}\left(t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right) - \frac{4}{25} \text{Dirac}\left(1, t - \frac{5}{2} \cdot 15^{1/3}\right) \left(t - \frac{5}{2} \cdot 15^{1/3}\right)^3$$

$$- \frac{24}{25} \text{Dirac}\left(t - \frac{5}{2} \cdot 15^{1/3}\right) \left(t - \frac{5}{2} \cdot 15^{1/3}\right)^2 - \frac{24}{25} \text{Heaviside}\left(t - \frac{5}{2} \cdot 15^{1/3}\right) \left(t - \frac{5}{2} \cdot 15^{1/3}\right)$$

> $plot(rhs(aceleracion), t = 0..26)$



$$\text{> } AceleracionMaxima := \text{subs}(t = \text{CuartoTiempoFinal}_1, \text{rhs}(\text{aceleracion})) : \text{evalf}(\%, 4) \quad (13)$$

$$2.959$$

$$\text{> } DesaceleracionMaxima := \text{subs}(t = 3 \cdot \text{CuartoTiempoFinal}_1, \text{rhs}(\text{aceleracion})) : \text{evalf}(\%, 4) \quad (14)$$

$$-2.959$$

$$\text{> } \text{sacudida} := \text{subs}(b = \text{CuartoTiempoFinal}_1, \text{diff}(\text{SolucionParticular}, t\$3)) \quad (15)$$

$$\text{sacudida} := \frac{d^3}{dt^3} y(t) = \frac{12}{25} - \frac{2}{25} \text{Dirac}(2, t - 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})^3 - \frac{18}{25} \text{Dirac}(1, t$$

$$- 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3})^2 - \frac{36}{25} \text{Dirac}(t - 10 \cdot 15^{1/3}) (t - 10 \cdot 15^{1/3}) - \frac{12}{25} \text{Heaviside}(t$$

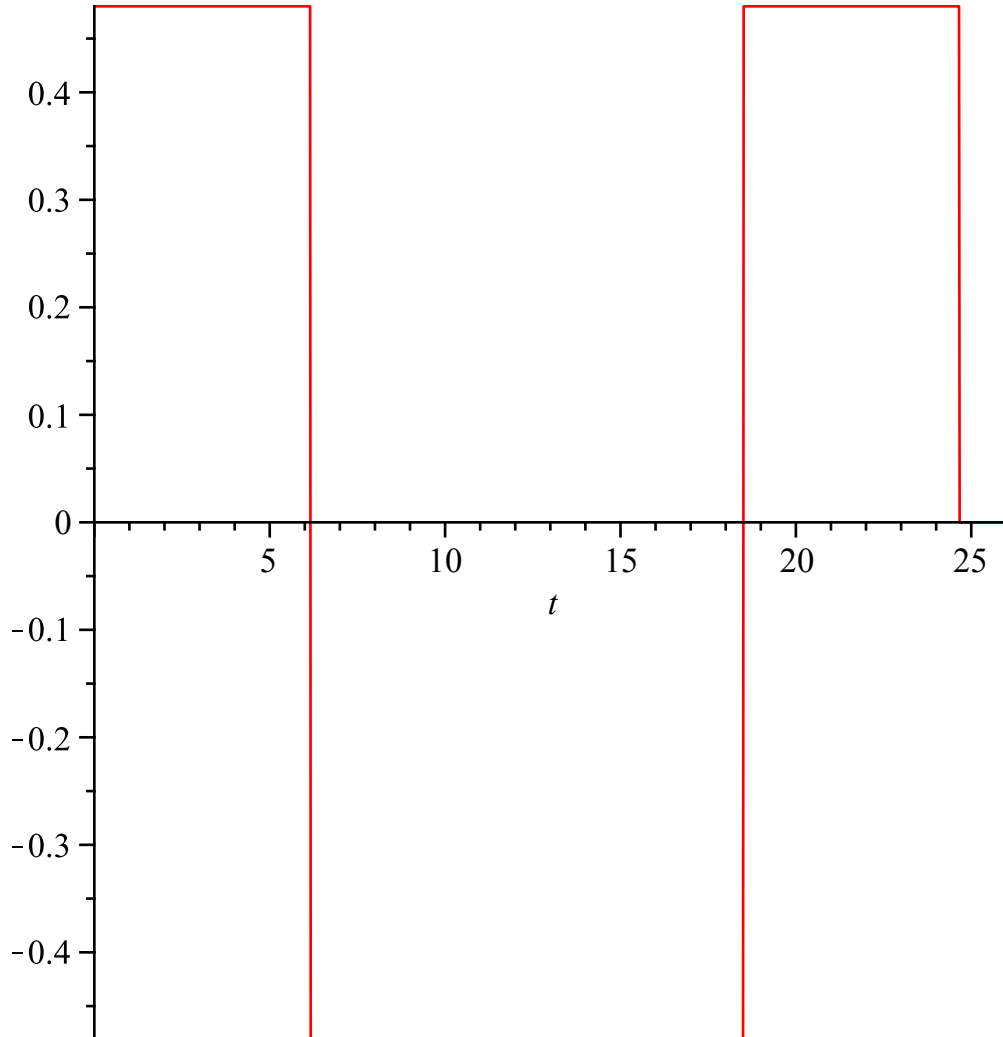
$$- 10 \cdot 15^{1/3}) + \frac{4}{25} \text{Dirac}\left(2, t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)^3 + \frac{36}{25} \text{Dirac}\left(1, t$$

$$- \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)^2 + \frac{72}{25} \text{Dirac}\left(t - \frac{15}{2} \cdot 15^{1/3}\right) \left(t - \frac{15}{2} \cdot 15^{1/3}\right)$$

$$+ \frac{24}{25} \text{Heaviside}\left(t - \frac{15}{2} \cdot 15^{1/3}\right) - \frac{4}{25} \text{Dirac}\left(2, t - \frac{5}{2} \cdot 15^{1/3}\right) \left(t - \frac{5}{2} \cdot 15^{1/3}\right)^3$$

$$-\frac{36}{25} \text{Dirac}\left(1, t - \frac{5}{2} 15^{1/3}\right) \left(t - \frac{5}{2} 15^{1/3}\right)^2 - \frac{72}{25} \text{Dirac}\left(t - \frac{5}{2} 15^{1/3}\right) \left(t - \frac{5}{2} 15^{1/3}\right) - \frac{24}{25} \text{Heaviside}\left(t - \frac{5}{2} 15^{1/3}\right)$$

> `plot(rhs(sacudida), t=0..26)`



> `SacudidaMaxima := subs($t = \frac{\text{CuartoTiempoFinal}_1}{2}$, rhs(sacudida)) : evalf(%, 4)`
0.4800

(16)

> `SacudidaMínima := subs($t = 2 \cdot \text{CuartoTiempoFinal}_1$, rhs(sacudida)) : evalf(%, 4)`
-0.4800

(17)

>

FIN DEL PROBLEMA