> *restart*

PROBLEMA DE LA TORRE MAYOR

> $Sacudida := \dfrac{48768}{100000} \cdot \text{Heaviside}(t) - \dfrac{2 \cdot 48768}{100000} \cdot \text{Heaviside}(t-a) + \dfrac{2 \cdot 48768}{100000} \cdot \text{Heaviside}(t$
$\qquad - 3 \cdot a) - \dfrac{48768}{100000} \cdot \text{Heaviside}(t - 4 \cdot a); plot(subs(a=1, Sacudida), t=-1..5)$

$Sacudida := \dfrac{1524}{3125}\, \text{Heaviside}(t) - \dfrac{3048}{3125}\, \text{Heaviside}(t-a) + \dfrac{3048}{3125}\, \text{Heaviside}(t - 3\,a)$
$\qquad - \dfrac{1524}{3125}\, \text{Heaviside}(t - 4\,a)$
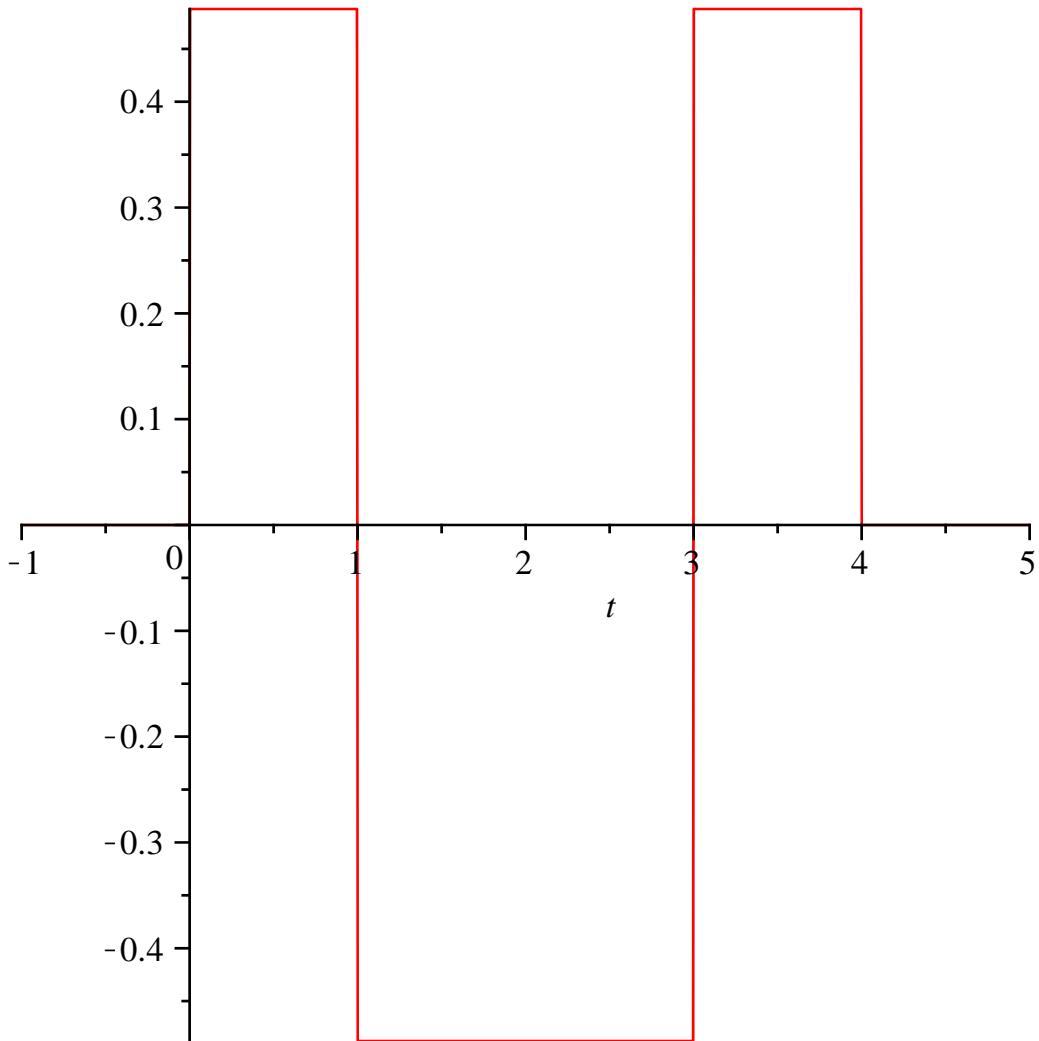
> $Ecuacion := diff(y(t), t\$3) = Sacudida : evalf(\%, 3)$

$\dfrac{d^3}{dt^3}\, y(t) = 0.488\, \text{Heaviside}(t) - 0.975\, \text{Heaviside}(t - 1.\,a) + 0.975\, \text{Heaviside}(t - 3.\,a)$ **(1)**
$\qquad - 0.488\, \text{Heaviside}(t - 4.\,a)$

> $Condiciones := y(0) = 0, D(y)(0) = 0, D(D(y))(0) = 0$

$\qquad\qquad Condiciones := y(0) = 0, D(y)(0) = 0, D^{(2)}(y)(0) = 0$ **(2)**

> $with(inttrans):$

> $TransLapEcua := subs(Condiciones, laplace(Ecuacion, t, s))$

$TransLapEcua := s^3 \, laplace(y(t), t, s) = \dfrac{1524}{3125 \, s} - \dfrac{3048}{3125} \, laplace(\text{Heaviside}(t-a), t, s)$ **(3)**

$+ \dfrac{3048}{3125} \, laplace(\text{Heaviside}(t-3a), t, s) - \dfrac{1524}{3125} \, laplace(\text{Heaviside}(t-4a), t, s)$

`>` $TransLapSol := simplify(isolate(TransLapEcua, laplace(y(t), t, s)))$

$TransLapSol := laplace(y(t), t, s) = -\dfrac{1524}{3125} \, \dfrac{1}{s^4} \, (-1 + 2 \, laplace(\text{Heaviside}(t-a), t, s) \, s$ **(4)**

$- 2 \, laplace(\text{Heaviside}(t-3a), t, s) \, s + laplace(\text{Heaviside}(t-4a), t, s) \, s)$

`>` $SolPart := invlaplace(TransLapSol, s, t)$

$SolPart := y(t) = \dfrac{254}{3125} \, t^3 - \dfrac{3048}{3125} \, \text{Heaviside}(-a) \, a^3 - \dfrac{254}{3125} \, \text{Heaviside}(t-4a) \, (t-4a)^3$ **(5)**

$+ \dfrac{508}{3125} \, \text{Heaviside}(t-3a) \, (t-3a)^3 - \dfrac{508}{3125} \, \text{Heaviside}(t-a) \, (t-a)^3$

`>` $EcuaAlge := subs\left(t = 4 \cdot a, \, \dfrac{254}{3125} \, t^3 - \dfrac{254}{3125} \, (t-4a)^3 + \dfrac{508}{3125} \, (t-3a)^3 - \dfrac{508}{3125} \, (t \right.$

$\left. - a)^3 = 225 \right)$

$$EcuaAlge := \dfrac{3048}{3125} \, a^3 = 225$$ **(6)**

`>` $Parametro := solve(EcuaAlge, a) : evalf(\%)$

    $6.132993801, \, -3.066496901 + 5.311328436 \, I, \, -3.066496901 - 5.311328436 \, I$ **(7)**

`>` $TiempoFinal := 4 \cdot Parametro_1 : evalf(\%)$

$$24.53197520$$ **(8)**

`>` $SolucionFinal := subs(a = Parametro_1, SolPart) : evalf(\%, 3)$

$y(t) = 0.0813 \, t^3 - 0.0813 \, \text{Heaviside}(t-24.5) \, (t-24.5)^3 + 0.163 \, \text{Heaviside}(t-18.4) \, (t$ **(9)**

$- 18.4)^3 - 0.163 \, \text{Heaviside}(t-6.13) \, (t-6.13)^3$

`>` $SolFin := y(t) = 0.0813 \, t^3 \cdot \text{Heaviside}(t) - 0.0813 \, \text{Heaviside}(t-24.5) \, (t-24.5)^3$

    $+ 0.163 \, \text{Heaviside}(t-18.4) \, (t-18.4)^3 - 0.163 \, \text{Heaviside}(t-6.13) \, (t-6.13)^3$

$SolFin := y(t) = 0.0813 \, t^3 \, \text{Heaviside}(t) - 0.0813 \, \text{Heaviside}(t-24.5) \, (t-24.5)^3$ **(10)**

$+ 0.163 \, \text{Heaviside}(t-18.4) \, (t-18.4)^3 - 0.163 \, \text{Heaviside}(t-6.13) \, (t-6.13)^3$

`>` $plot(rhs(SolFin), t = -10 .. 28)$

> $plot(\,rhs(\,diff\,(SolFin,\,t)\,)\,),\,t = \text{-}10\,..30\,);\;VelMax := subs\big(\,t = 2 \cdot Parametro_1,\,rhs(\,diff\,(SolFin,$
$t)\,)\,)\big)\,:\,evalf\,(\%)$
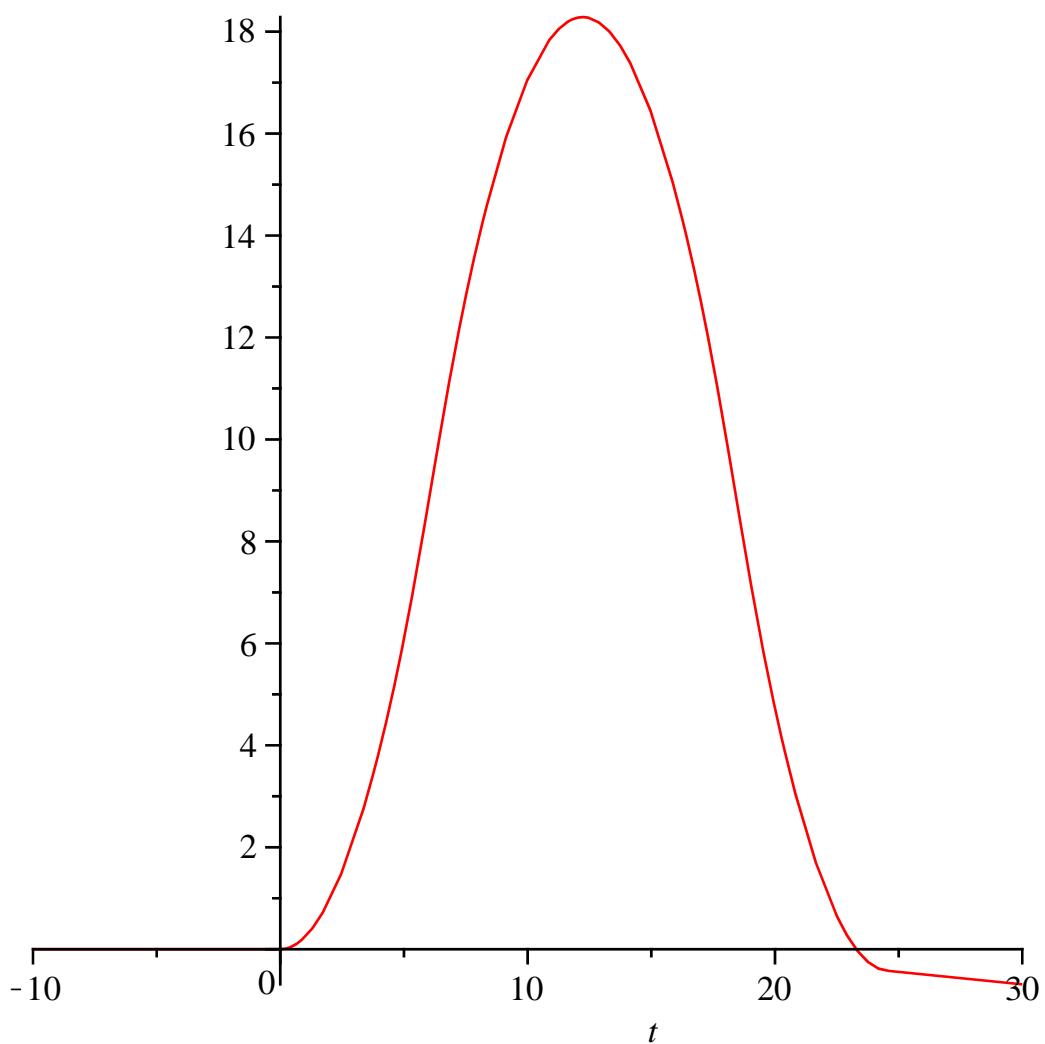
$$18.28482267 \qquad \textbf{(11)}$$

> $plot\big(rhs\big(diff\big(SolFin, t\$2\big)\big), t = -10 ..30\big); AcelMax := subs\big(t = Parametro_1, rhs\big(diff\big(SolFin, t\$2\big)\big)\big) : evalf\,(\%)$
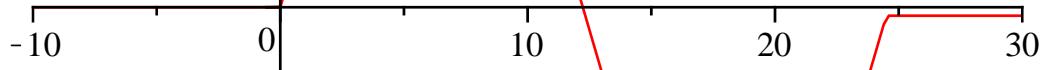
$$2.988746438 \tag{12}$$

> $plot(rhs(diff(SolFin, t\$3)), t = -10 .. 30)$
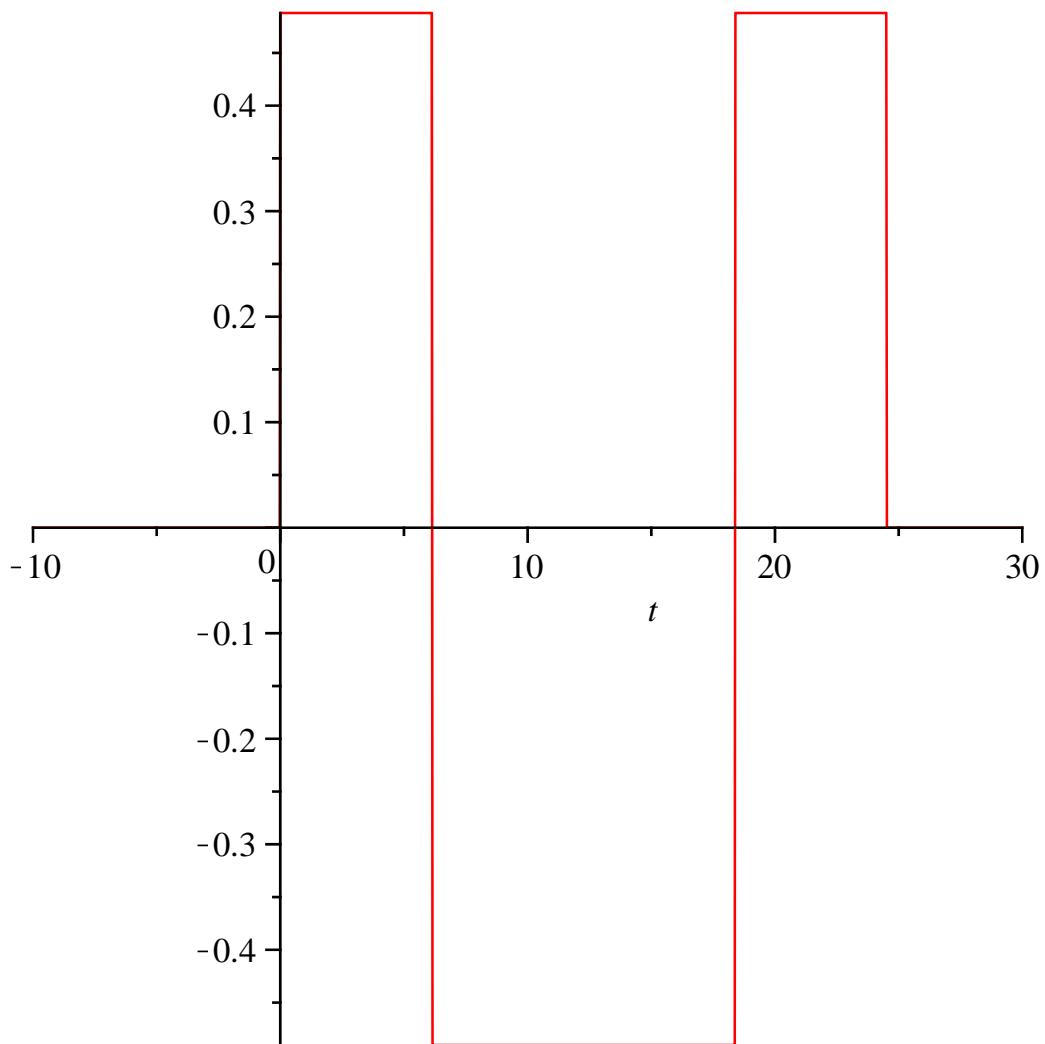
> $TransLapEcua := expand(subs(Condiciones, laplace(subs(a = Parametro_1, Ecuacion), t, s)))$

$$TransLapEcua := s^3\, laplace(y(t), t, s) = \frac{1524}{3125\, s} - \frac{3048}{3125}\, \frac{e^{-\frac{25}{254}\, s\, 241935^{1/3}}}{s}$$

$$+ \frac{3048}{3125}\, \frac{e^{-\frac{75}{254}\, s\, 241935^{1/3}}}{s} - \frac{1524}{3125}\, \frac{e^{-\frac{50}{127}\, s\, 241935^{1/3}}}{s}$$

(13)

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