

> restart

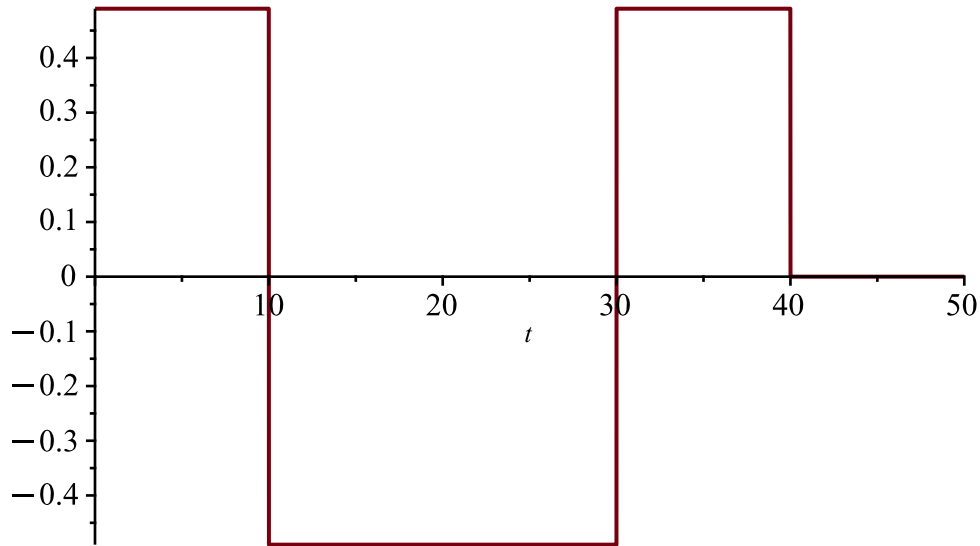
> Ecuacion := diff(y(t), t\$3) = Sacudida

$$Ecuacion := \frac{d^3}{dt^3} y(t) = Sacudida \quad (1)$$

> Sacudida :=  $\frac{49}{100} \cdot \text{Heaviside}(t) - 2 \cdot \frac{49}{100} \cdot \text{Heaviside}(t - a) + \frac{2 \cdot 49}{100} \cdot \text{Heaviside}(t - 3 \cdot a)$   
 $- \frac{49}{100} \cdot \text{Heaviside}(t - 4 \cdot a)$

$$Sacudida := \frac{49 \text{ Heaviside}(t)}{100} - \frac{49 \text{ Heaviside}(t - a)}{50} + \frac{49 \text{ Heaviside}(t - 3 a)}{50} - \frac{49 \text{ Heaviside}(t - 4 a)}{100} \quad (2)$$

> plot(subs(a = 10, Sacudida), t = 0 .. 50)



> CondIni := y(0) = 0, D(y)(0) = 0, D(D(y))(0) = 0

$$CondIni := y(0) = 0, D(y)(0) = 0, D^{(2)}(y)(0) = 0 \quad (3)$$

> with(inttrans) :

> EcuacionTL := subs(CondIni, laplace(Ecuacion, t, s))

$$EcuacionTL := s^3 \mathcal{L}(y(t), t, s) = \frac{49}{100 s} - \frac{49 \mathcal{L}(\text{Heaviside}(t - a), t, s)}{50} + \frac{49 \mathcal{L}(\text{Heaviside}(t - 3 a), t, s)}{50} - \frac{49 \mathcal{L}(\text{Heaviside}(t - 4 a), t, s)}{100} \quad (4)$$

> SolucionTL := isolate(EcuacionTL, laplace(y(t), t, s))

$$SolucionTL := \mathcal{L}(y(t), t, s) = \frac{1}{s^3} \left( \frac{49}{100 s} - \frac{49 \mathcal{L}(\text{Heaviside}(t - a), t, s)}{50} + \frac{49 \mathcal{L}(\text{Heaviside}(t - 3 a), t, s)}{50} - \frac{49 \mathcal{L}(\text{Heaviside}(t - 4 a), t, s)}{100} \right) \quad (5)$$

> Solucion := invlaplace(SolucionTL, s, t)

(6)

$$\begin{aligned} \text{Solucion} := y(t) = & \frac{49 t^3}{600} - \frac{49 \text{Heaviside}(t-a) (t-a)^3}{300} - \frac{49 \text{Heaviside}(-a) a^3}{50} \\ & + \frac{49 \text{Heaviside}(t-3a) (t-3a)^3}{300} - \frac{49 \text{Heaviside}(t-4a) (t-4a)^3}{600} \end{aligned} \quad (6)$$

> *RecorridoFinal* := subs(*t* = 4·*a*, rhs(*Solucion*) = 225)

$$\begin{aligned} \text{RecorridoFinal} := & \frac{392 a^3}{75} - \frac{441 \text{Heaviside}(3a) a^3}{100} - \frac{49 \text{Heaviside}(-a) a^3}{50} \\ & + \frac{49 \text{Heaviside}(a) a^3}{300} = 225 \end{aligned} \quad (7)$$

> *RecorridoFinalDos* := subs(Heaviside(3 *a*) = 1, Heaviside(−*a*) = 0, Heaviside(3 *a*) = 1, *RecorridoFinal*)

$$\text{RecorridoFinalDos} := \frac{49 a^3}{50} = 225 \quad (8)$$

> *TiempoFinalEntreCuatro* := solve(*RecorridoFinalDos*, *a*) : evalf(%, 4)

$$6.124, -3.061 + 5.303 \text{I}, -3.061 - 5.303 \text{I} \quad (9)$$

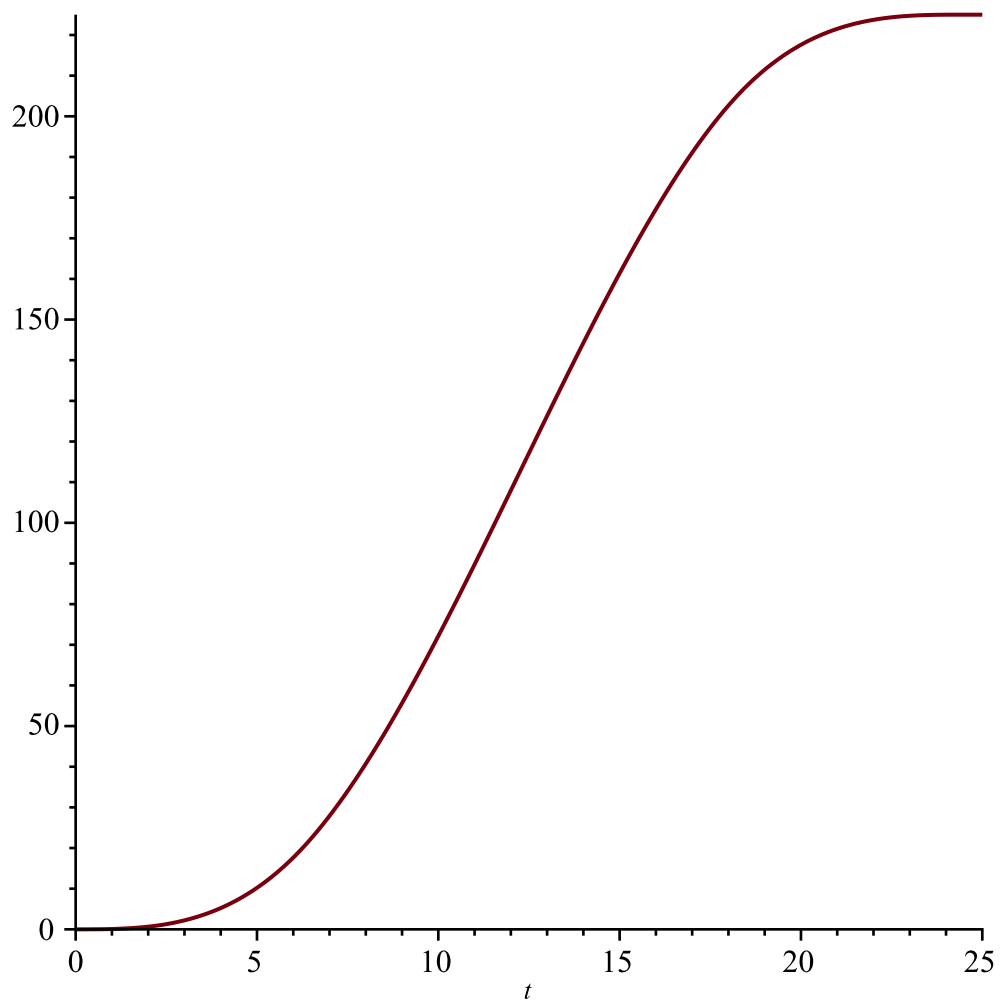
> *TiempoFinalUltimo* := *TiempoFinalEntreCuatro*[1]·4 : evalf(%, 4)

$$24.49 \quad (10)$$

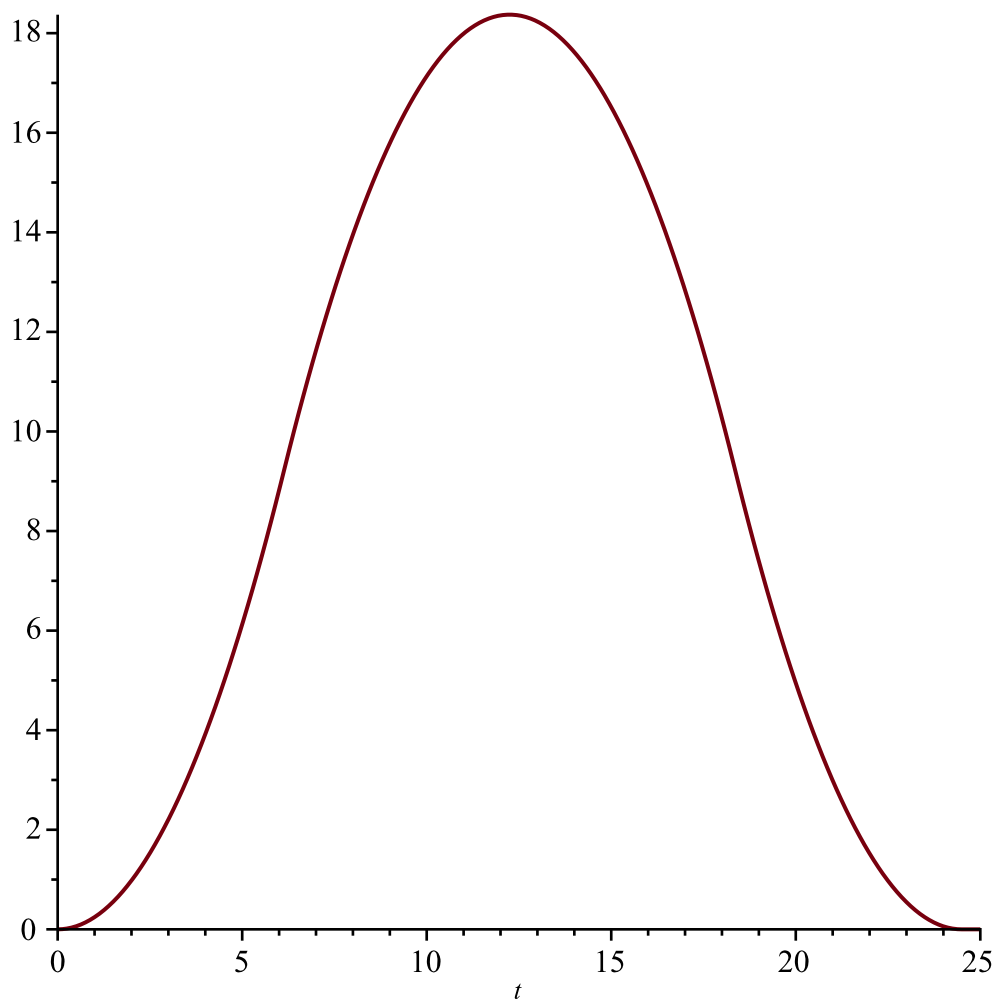
> *SolucionFinal* := subs(*a* = *TiempoFinalEntreCuatro*[1], *Solucion*)

$$\begin{aligned} \text{SolucionFinal} := y(t) = & \frac{49 t^3}{600} - \frac{49 \text{Heaviside}\left(t - \frac{5 \cdot 630^{1/3}}{7}\right) \left(t - \frac{5 \cdot 630^{1/3}}{7}\right)^3}{300} \\ & - 225 \text{Heaviside}\left(-\frac{5 \cdot 630^{1/3}}{7}\right) + \frac{49 \text{Heaviside}\left(t - \frac{15 \cdot 630^{1/3}}{7}\right) \left(t - \frac{15 \cdot 630^{1/3}}{7}\right)^3}{300} \\ & - \frac{49 \text{Heaviside}\left(t - \frac{20 \cdot 630^{1/3}}{7}\right) \left(t - \frac{20 \cdot 630^{1/3}}{7}\right)^3}{600} \end{aligned} \quad (11)$$

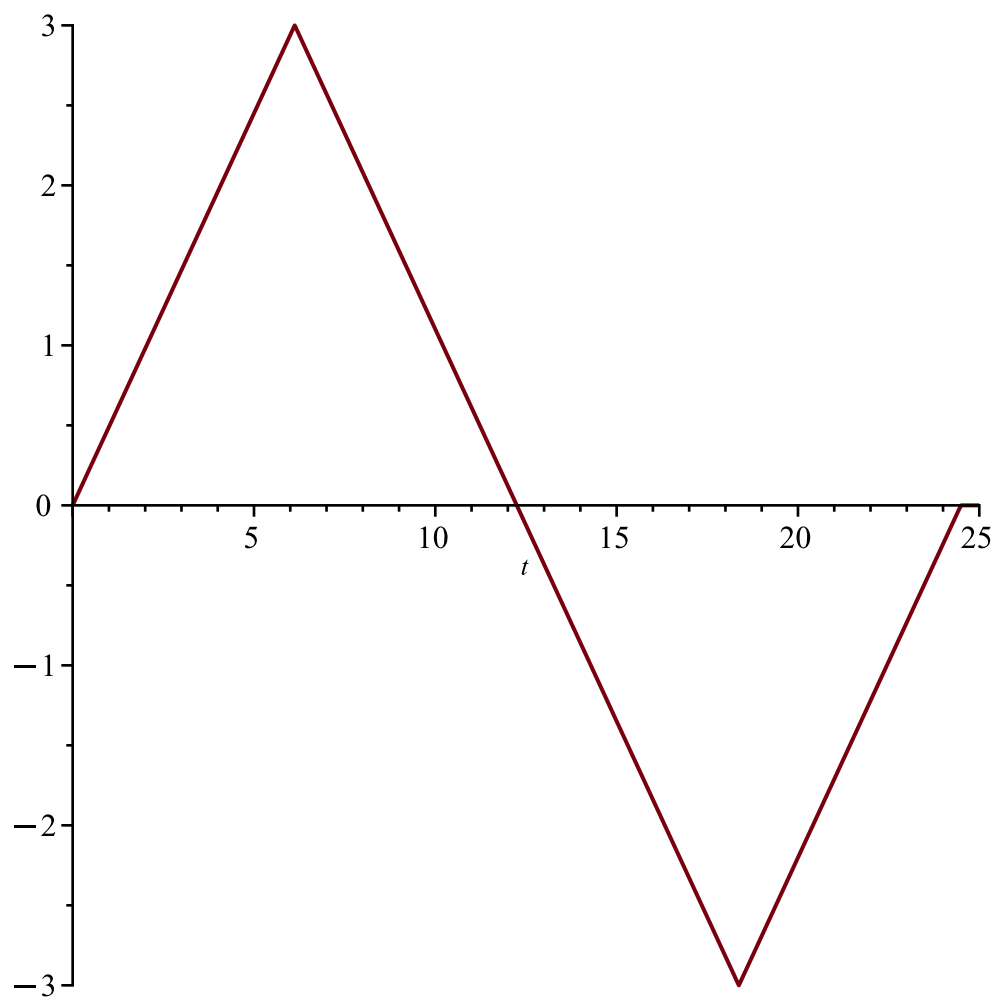
> plot(rhs(*SolucionFinal*), *t* = 0..25)



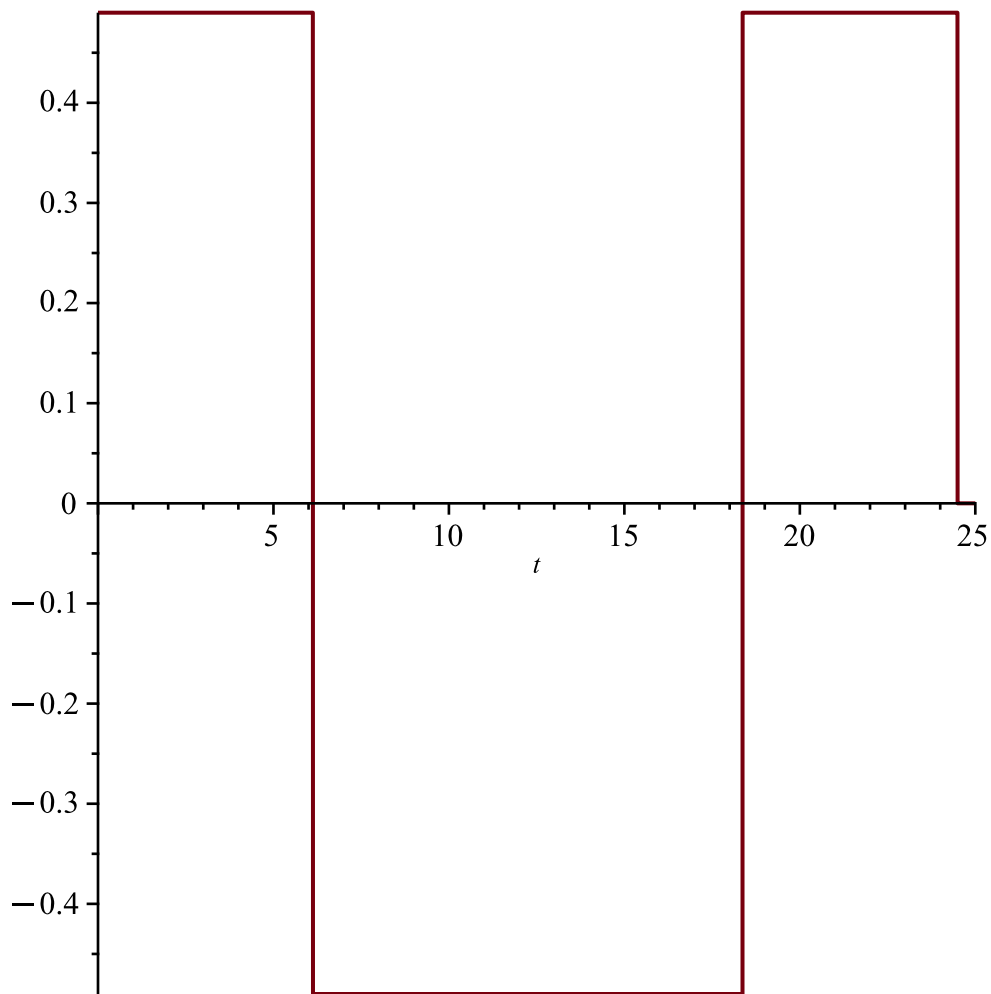
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> plot(rhs(diff(SolucionFinal, t)), t = 0..25)
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> plot(rhs(diff(SolucionFinal, t$2)), t=0..25)
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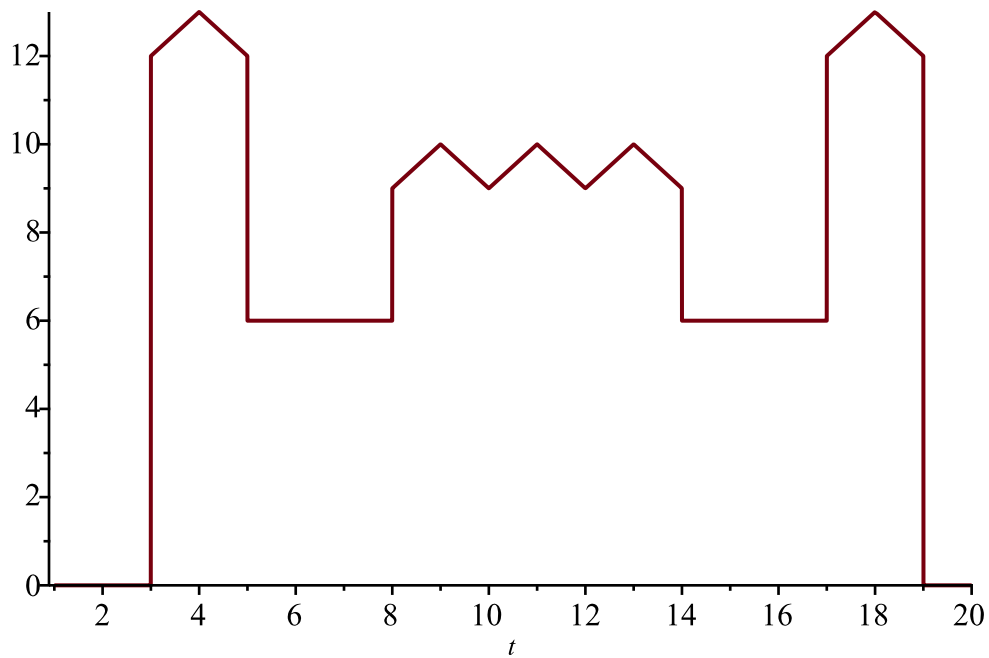
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> plot(rhs(diff(SolucionFinal, t$3)), t = 0..25)
```



> restart

>  $Castillo := 12 \cdot \text{Heaviside}(t - 3) + (t - 3) \cdot \text{Heaviside}(t - 3) - 2 \cdot (t - 4) \cdot \text{Heaviside}(t - 4) + (t - 5) \cdot \text{Heaviside}(t - 5) - 6 \cdot \text{Heaviside}(t - 5) + 3 \cdot \text{Heaviside}(t - 8) + (t - 8) \cdot \text{Heaviside}(t - 8) - 2 \cdot (t - 9) \cdot \text{Heaviside}(t - 9) + 2 \cdot (t - 10) \cdot \text{Heaviside}(t - 10) - 2 \cdot (t - 11) \cdot \text{Heaviside}(t - 11) + 2 \cdot (t - 12) \cdot \text{Heaviside}(t - 12) - 2 \cdot (t - 13) \cdot \text{Heaviside}(t - 13) + (t - 14) \cdot \text{Heaviside}(t - 14) - 3 \cdot \text{Heaviside}(t - 14) + 6 \cdot \text{Heaviside}(t - 17) + (t - 17) \cdot \text{Heaviside}(t - 17) - 2 \cdot (t - 18) \cdot \text{Heaviside}(t - 18) + (t - 19) \cdot \text{Heaviside}(t - 19) - 12 \cdot \text{Heaviside}(t - 19); \text{plot}(Castillo, t = 1 .. 20)$

$Castillo := 12 \text{ Heaviside}(t - 3) + (t - 3) \text{ Heaviside}(t - 3) - 2 (t - 4) \text{ Heaviside}(t - 4) + (t - 5) \text{ Heaviside}(t - 5) - 6 \text{ Heaviside}(t - 5) + 3 \text{ Heaviside}(t - 8) + (t - 8) \text{ Heaviside}(t - 8) - 2 (t - 9) \text{ Heaviside}(t - 9) + 2 (t - 10) \text{ Heaviside}(t - 10) - 2 (t - 11) \text{ Heaviside}(t - 11) + 2 (t - 12) \text{ Heaviside}(t - 12) - 2 (t - 13) \text{ Heaviside}(t - 13) + (t - 14) \text{ Heaviside}(t - 14) - 3 \text{ Heaviside}(t - 14) + 6 \text{ Heaviside}(t - 17) + (t - 17) \text{ Heaviside}(t - 17) - 2 (t - 18) \text{ Heaviside}(t - 18) + (t - 19) \text{ Heaviside}(t - 19) - 12 \text{ Heaviside}(t - 19)$



> restart

> Ecua := y'' - y' - 6 y = 6 · exp(3 · x) + 2 · exp(-2 · x)

$$Ecua := \frac{d^2}{dx^2} y(x) - \frac{d}{dx} y(x) - 6 y(x) = 6 e^{3x} + 2 e^{-2x} \quad (12)$$

> CondIni := y(0) = 0, D(y)(0) = 4/5

$$CondIni := y(0) = 0, D(y)(0) = \frac{4}{5} \quad (13)$$

> with(inttrans) :

> EcuaTL := subs(CondIni, laplace(Ecua, x, s))

$$EcuaTL := s^2 \mathcal{L}(y(x), x, s) - \frac{4}{5} - s \mathcal{L}(y(x), x, s) - 6 \mathcal{L}(y(x), x, s) = \frac{2(4s + 3)}{(s - 3)(s + 2)} \quad (14)$$

> SolTL := simplify(isolate(EcuaTL, laplace(y(x), x, s)))

$$SolTL := \mathcal{L}(y(x), x, s) = \frac{4s^2 + 36s + 6}{5(s - 3)^2(s + 2)^2} \quad (15)$$

> SolucionParticular := simplify(invlaplace(SolTL, s, x))

$$SolucionParticular := y(x) = \frac{2x(3e^{5x} - 1)e^{-2x}}{5} \quad (16)$$

> SolucionParticularFinal := y(x) = 6/5 · x · exp(3 · x) - 2/5 · x · exp(-2 · x)

$$SolucionParticularFinal := y(x) = \frac{6xe^{3x}}{5} - \frac{2xe^{-2x}}{5} \quad (17)$$

> DerSolPartFinal := diff(SolucionParticularFinal, x)

$$DerSolPartFinal := \frac{d}{dx} y(x) = \frac{6e^{3x}}{5} + \frac{18xe^{3x}}{5} - \frac{2e^{-2x}}{5} + \frac{4xe^{-2x}}{5} \quad (18)$$

$$\begin{array}{l} \text{> } ComprobarUno := subs(x=0, SolucionParticularFinal) \\ \text{ } ComprobarUno := y(0) = 0 \end{array} \quad (19)$$

$$\begin{array}{l} \text{> } ComprobarDos := D(y)(0) = simplify(subs(x=0, rhs(diff(SolucionParticularFinal, x)))) \\ \text{ } ComprobarDos := D(y)(0) = \frac{4}{5} \end{array} \quad (20)$$

$$\begin{array}{l} \text{> } ComprobarTres := simplify(eval(subs(y(x) = rhs(SolucionParticularFinal), lhs(Ecua) \\ \text{ } \quad - rhs(Ecua) = 0))) \\ \text{ } ComprobarTres := 0 = 0 \end{array} \quad (21)$$

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