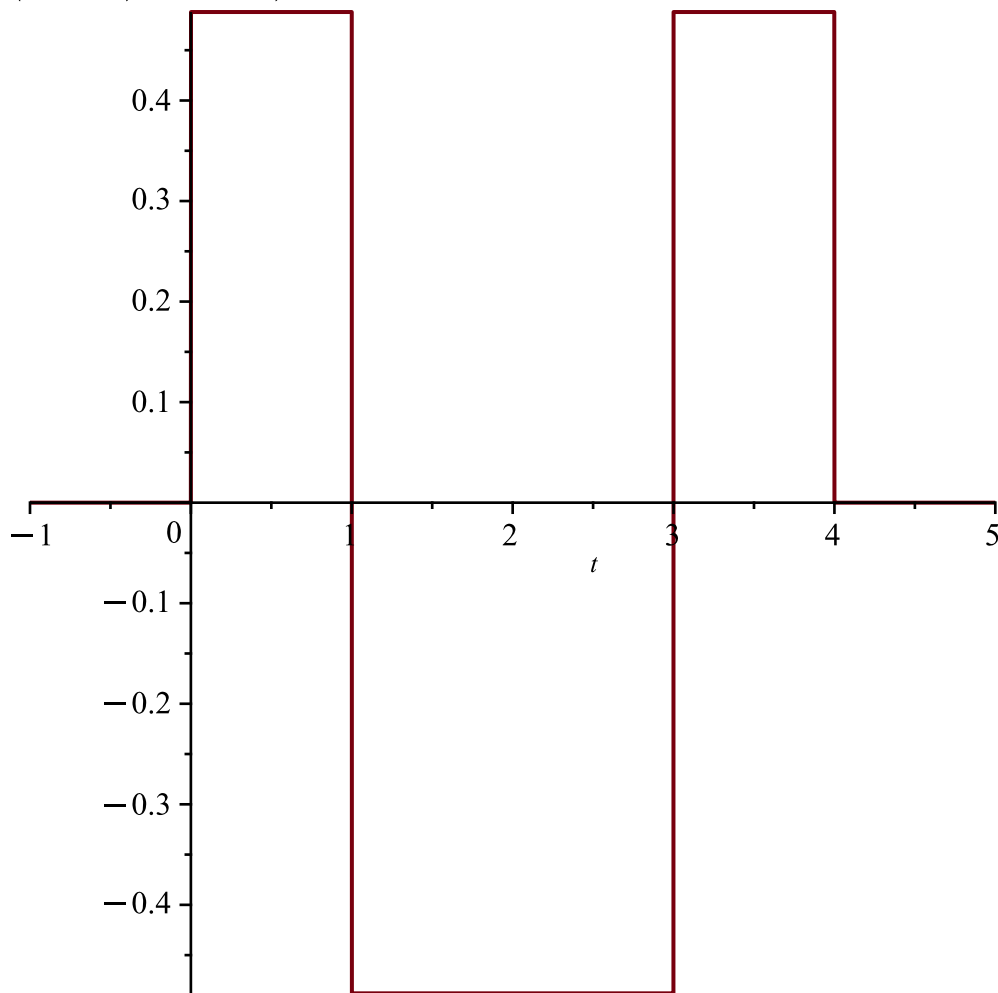


```
> restart
```

```
> S :=  $\frac{488}{1000} \cdot \text{Heaviside}(t) - \frac{2 \cdot 488}{1000} \cdot \text{Heaviside}(t - a) + \frac{2 \cdot 488}{1000} \cdot \text{Heaviside}(t - 3 \cdot a) - \frac{488}{1000} \cdot \text{Heaviside}(t - 4 \cdot a)$ 
```

$$S := \frac{61 \text{ Heaviside}(t)}{125} - \frac{122 \text{ Heaviside}(t - a)}{125} + \frac{122 \text{ Heaviside}(t - 3 a)}{125} - \frac{61 \text{ Heaviside}(t - 4 a)}{125} \quad (1)$$

```
> plot(subs(a = 1, S), t = -1 .. 5)
```



```
> Ecua := diff(y(t), t, t, t) = S
```

$$Ecua := \frac{d^3}{dt^3} y(t) = \frac{61 \text{ Heaviside}(t)}{125} - \frac{122 \text{ Heaviside}(t - a)}{125} + \frac{122 \text{ Heaviside}(t - 3 a)}{125} - \frac{61 \text{ Heaviside}(t - 4 a)}{125} \quad (2)$$

```
> 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) :
```

```
> EcuaTransLap := subs(CondIni, laplace(Ecua, t, s))
```

$$\begin{aligned} EcuaTransLap := s^3 \mathcal{L}(y(t), t, s) = & \frac{61}{125 s} - \frac{122 \mathcal{L}(\text{Heaviside}(t - a), t, s)}{125} \\ & + \frac{122 \mathcal{L}(\text{Heaviside}(t - 3 a), t, s)}{125} - \frac{61 \mathcal{L}(\text{Heaviside}(t - 4 a), t, s)}{125} \end{aligned} \quad (4)$$

$$\begin{aligned} & \text{> } SolTransLap := isolate(EcuaTransLap, laplace(y(t), t, s)) \\ SolTransLap := \mathcal{L}(y(t), t, s) = & \frac{1}{s^3} \left(\frac{61}{125 s} - \frac{122 \mathcal{L}(\text{Heaviside}(t - a), t, s)}{125} \right. \\ & \left. + \frac{122 \mathcal{L}(\text{Heaviside}(t - 3 a), t, s)}{125} - \frac{61 \mathcal{L}(\text{Heaviside}(t - 4 a), t, s)}{125} \right) \end{aligned} \quad (5)$$

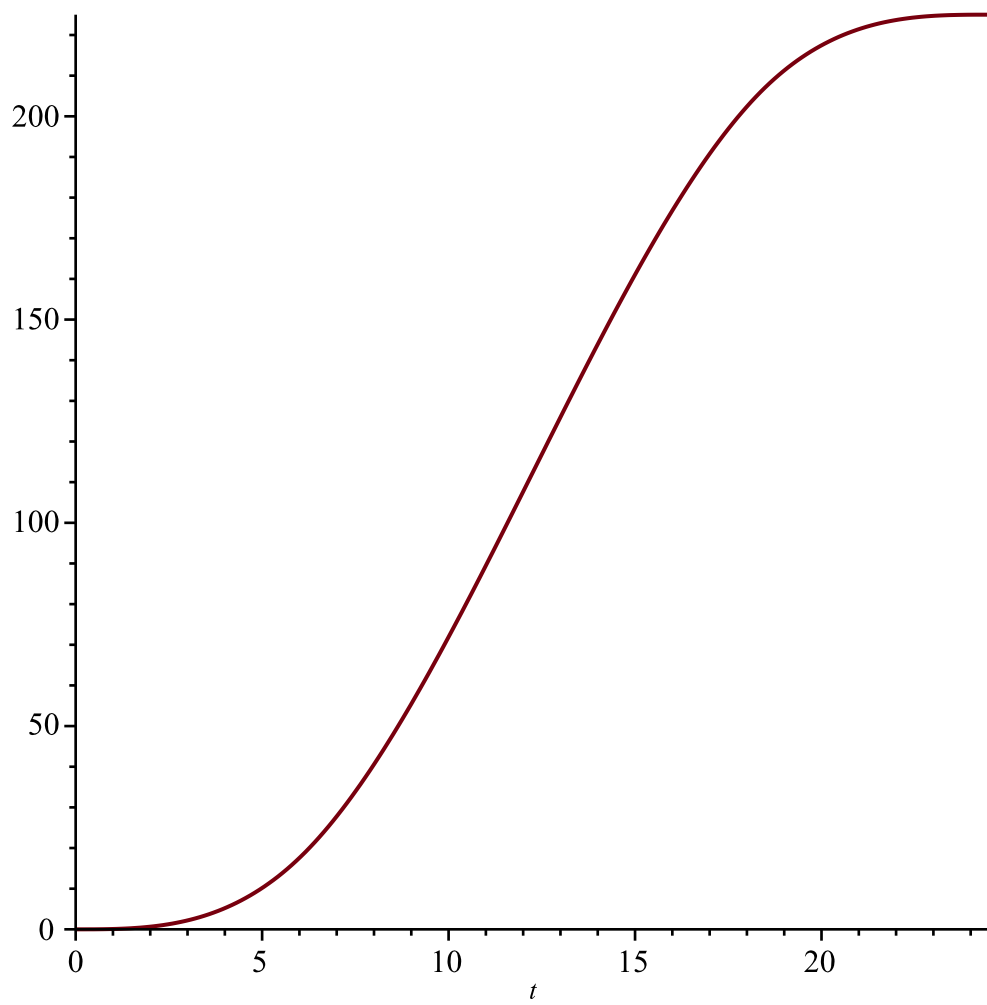
$$\begin{aligned} & \text{> } SolPart := invlaplace(SolTransLap, s, t) \\ SolPart := y(t) = & \frac{61 t^3}{750} - \frac{61 \text{Heaviside}(t - a) (t - a)^3}{375} - \frac{122 \text{Heaviside}(-a) a^3}{125} \\ & + \frac{61 (t - 3 a)^3 \text{Heaviside}(t - 3 a)}{375} - \frac{61 (t - 4 a)^3 \text{Heaviside}(t - 4 a)}{750} \end{aligned} \quad (6)$$

$$\begin{aligned} & \text{> } SolReal := subs(t = 4 \cdot a, rhs(SolPart) = 225) \\ SolReal := & \frac{1952 a^3}{375} - \frac{549 \text{Heaviside}(3 a) a^3}{125} - \frac{122 \text{Heaviside}(-a) a^3}{125} \\ & + \frac{61 a^3 \text{Heaviside}(a)}{375} = 225 \end{aligned} \quad (7)$$

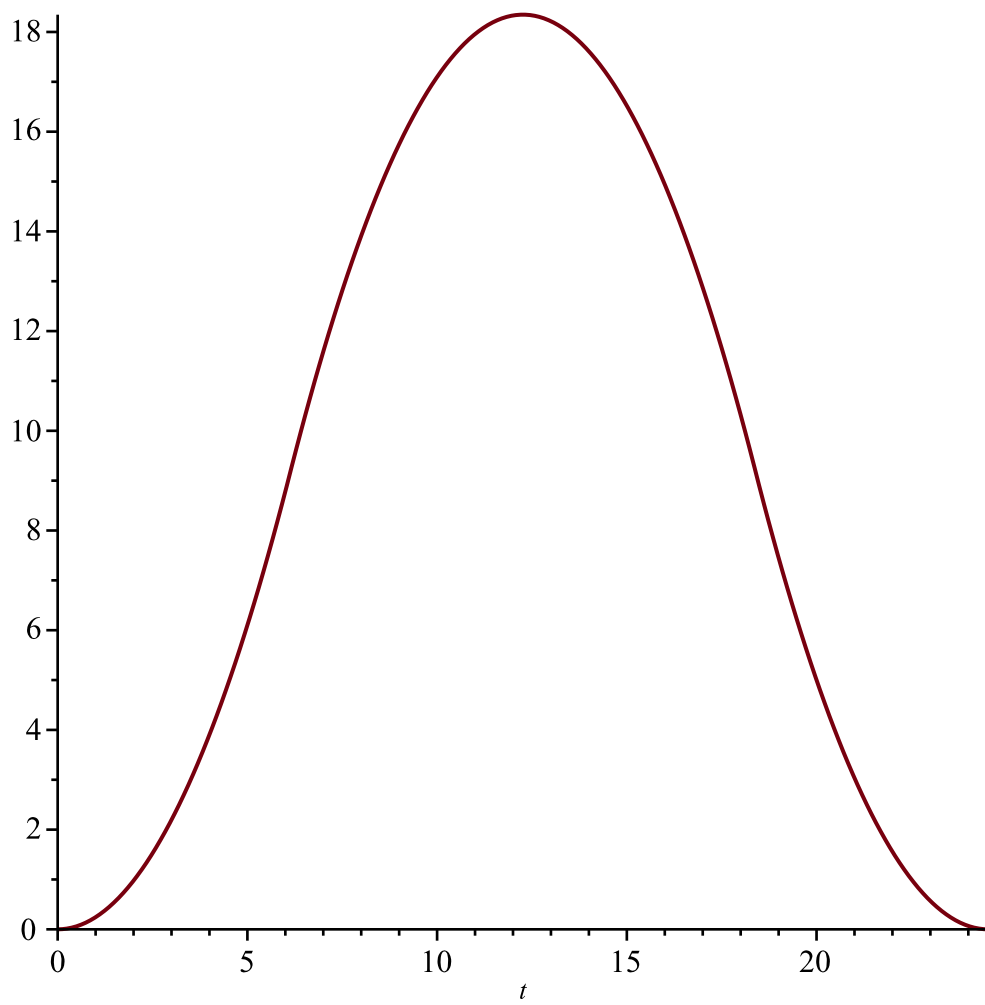
$$\begin{aligned} & \text{> } Para := solve(subs(\text{Heaviside}(a) = 1, \text{Heaviside}(3 \cdot a) = 0, \text{Heaviside}(-a) = 0, SolReal), a) : \\ & \quad evalf(\%, 5) \end{aligned} \quad (8)$$

$$\begin{aligned} & \text{> } TiempoFinal := Para[1] \cdot 4 : evalf(\%, 5) \\ & \quad 24.526 \end{aligned} \quad (9)$$

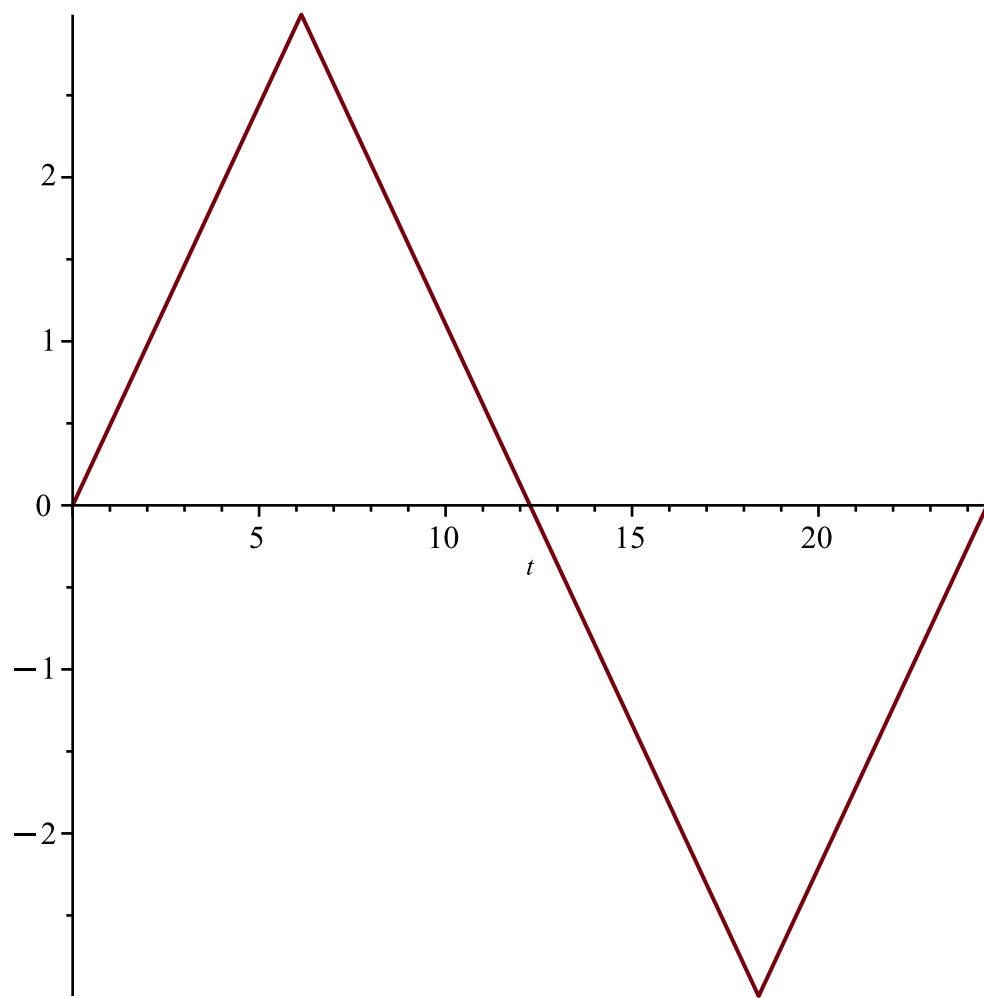
$$\text{> } SolFinal := subs(a = Para[1], SolPart) : plot(rhs(SolFinal), t = 0 .. TiempoFinal)$$



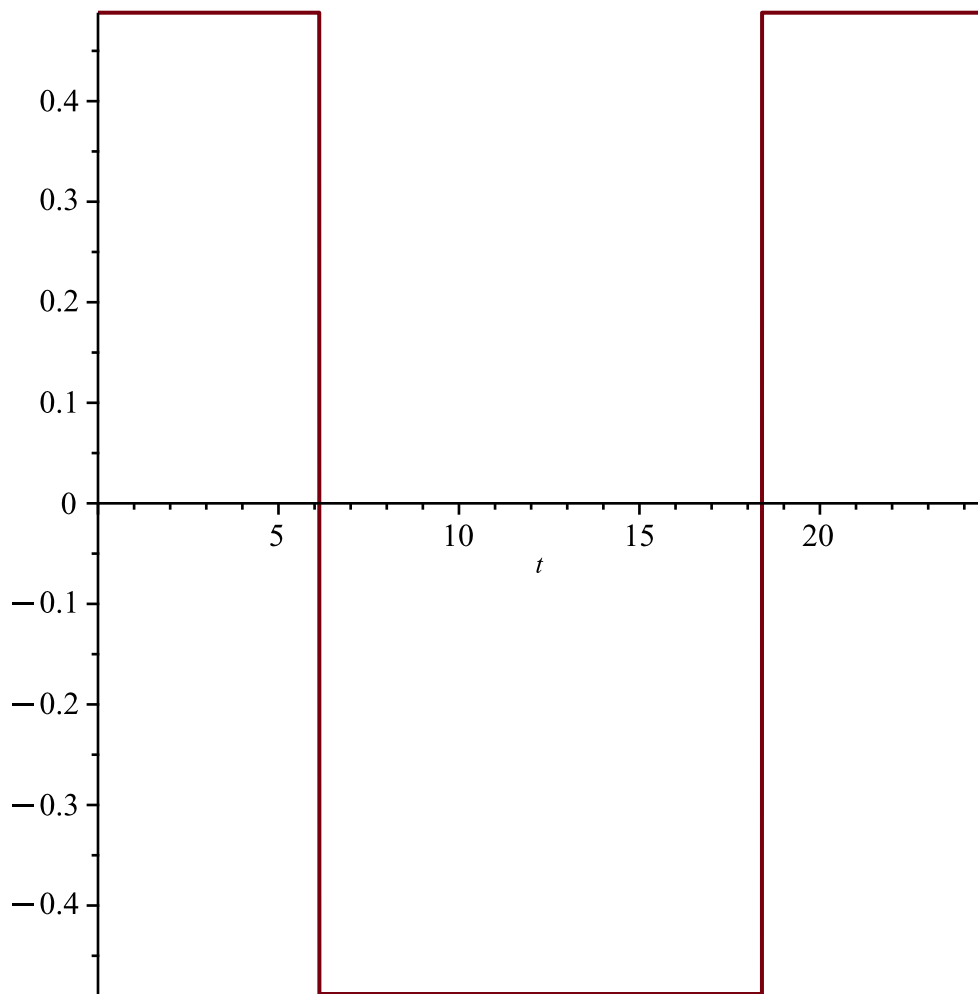
```
=  
> plot(rhs(diff(SolFinal,t)), t=0..TiempoFinal)
```



```
> plot(rhs(diff(SolFinal, t, t)), t=0..TiempoFinal)
```



=
 $\text{plot}(\text{rhs}(\text{diff}(\text{SolFinal}, t, t, t)), t=0 \dots \text{TiempoFinal})$



```
> evalf(SolFinal, 3)
```

$$y(t) = 0.0813 t^3 - 0.163 \operatorname{Heaviside}(t - 6.15) (t - 6.15)^3 + 0.163 (t - 18.4)^3 \operatorname{Heaviside}(t - 18.4) - 0.0813 (t - 24.6)^3 \operatorname{Heaviside}(t - 24.6) \quad (10)$$

```
> restart
```

```
> Sistema := diff(x[1](t), t) = -x[2](t) + 2*exp(2*t), diff(x[2](t), t) = x[1](t) - t^2 :
Sistema[1]; Sistema[2]
```

$$\begin{aligned} \frac{d}{dt} x_1(t) &= -x_2(t) + 2e^{2t} \\ \frac{d}{dt} x_2(t) &= x_1(t) - t^2 \end{aligned} \quad (11)$$

```
> CondIni := x[1](0) = 4, x[2](0) = -6
```

$$\text{CondIni} := x_1(0) = 4, x_2(0) = -6 \quad (12)$$

```
> AA := array([[0, -1], [1, 0]])
```

$$AA := \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad (13)$$

```
> Xcero := array([4, -6])
```

$$Xcero := \begin{bmatrix} 4 & -6 \end{bmatrix} \quad (14)$$

$$\begin{aligned} &> BB := \text{array}([2 \cdot \exp(2 \cdot t), -t^2]) \\ &BB := \begin{bmatrix} 2 e^{2t} & -t^2 \end{bmatrix} \end{aligned} \quad (15)$$

$\text{with}(\text{linalg}) :$

$$\begin{aligned} &> \text{MatExp} := \text{exponential}(AA, t) \\ &\text{MatExp} := \begin{bmatrix} \cos(t) & -\sin(t) \\ \sin(t) & \cos(t) \end{bmatrix} \end{aligned} \quad (16)$$

$$\begin{aligned} &> \text{ParteUno} := \text{evalm}(\text{MatExp} \&* \text{Xcero}) : x[1](t) = \text{ParteUno}[1]; x[2](t) = \text{ParteUno}[2] \\ &x_1(t) = 4 \cos(t) + 6 \sin(t) \\ &x_2(t) = 4 \sin(t) - 6 \cos(t) \end{aligned} \quad (17)$$

$$\begin{aligned} &> \text{MatExpTau} := \text{map}(\text{rcurry}(\text{eval}, t = t - \text{tau}'), \text{MatExp}) \\ &\text{MatExpTau} := \begin{bmatrix} \cos(t - \tau) & -\sin(t - \tau) \\ \sin(t - \tau) & \cos(t - \tau) \end{bmatrix} \end{aligned} \quad (18)$$

$$\begin{aligned} &> \text{BBtau} := \text{map}(\text{rcurry}(\text{eval}, t = \text{tau}'), BB) \\ &\text{BBtau} := \begin{bmatrix} 2 e^{2\tau} & -\tau^2 \end{bmatrix} \end{aligned} \quad (19)$$

$$\begin{aligned} &> \text{ProdTau} := \text{evalm}(\text{MatExpTau} \&* \text{BBtau}) : \text{ProdTau}[1]; \text{ProdTau}[2] \\ &2 \cos(t - \tau) e^{2\tau} + \sin(t - \tau) \tau^2 \\ &2 \sin(t - \tau) e^{2\tau} - \cos(t - \tau) \tau^2 \end{aligned} \quad (20)$$

$$\begin{aligned} &> \text{ParteDos} := \text{map}(\text{int}, \text{ProdTau}, \text{tau} = 0 .. t) : \text{xx}[1](t) = \text{ParteDos}[1]; \text{xx}[2](t) = \text{ParteDos}[2] \\ &\text{xx}_1(t) = -2 + \frac{6 \cos(t)}{5} + \frac{2 \sin(t)}{5} + \frac{4 e^{2t}}{5} + t^2 \\ &\text{xx}_2(t) = \frac{6 \sin(t)}{5} - \frac{2 \cos(t)}{5} - 2t + \frac{2 e^{2t}}{5} \end{aligned} \quad (21)$$

$$\begin{aligned} &> \text{ComprobarUno} := \text{simplify}(\text{subs}(t = 0, \text{ParteDos}[1])) \\ &\text{ComprobarUno} := 0 \end{aligned} \quad (22)$$

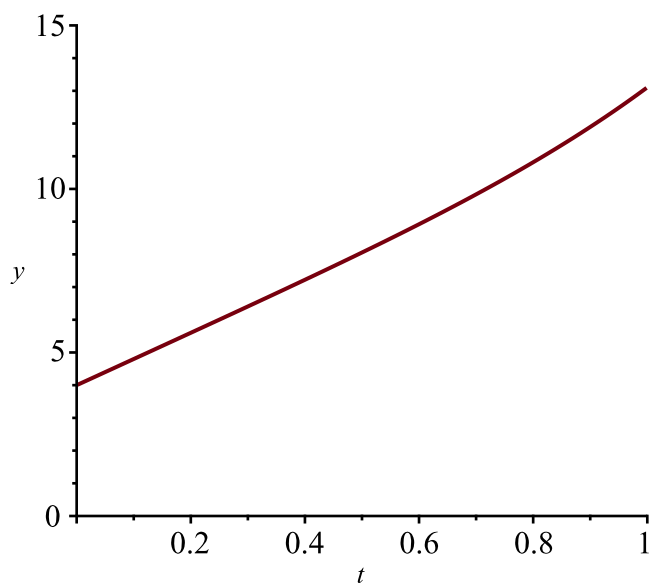
$$\begin{aligned} &> \text{ComprobarDos} := \text{simplify}(\text{subs}(t = 0, \text{ParteDos}[2])) \\ &\text{ComprobarDos} := 0 \end{aligned} \quad (23)$$

$$\begin{aligned} &> \text{SolFinal} := \text{evalm}(\text{ParteUno} + \text{ParteDos}) : x[1](t) = \text{SolFinal}[1]; x[2](t) = \text{SolFinal}[2]; \\ &x_1(t) = \frac{26 \cos(t)}{5} + \frac{32 \sin(t)}{5} - 2 + \frac{4 e^{2t}}{5} + t^2 \\ &x_2(t) = \frac{26 \sin(t)}{5} - \frac{32 \cos(t)}{5} - 2t + \frac{2 e^{2t}}{5} \end{aligned} \quad (24)$$

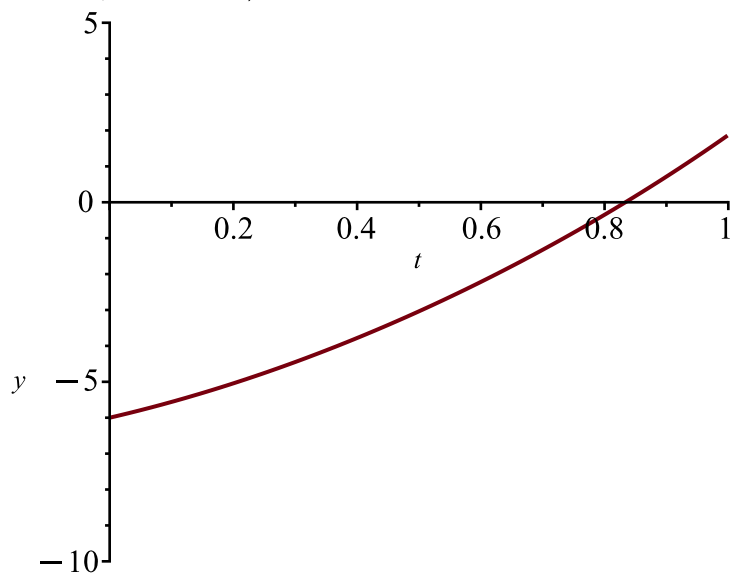
$$\begin{aligned} &> \text{ComprobarTres} := \text{simplify}(\text{subs}(t = 0, \text{SolFinal}[1])) \\ &\text{ComprobarTres} := 4 \end{aligned} \quad (25)$$

$$\begin{aligned} &> \text{ComprobarCuatro} := \text{simplify}(\text{subs}(t = 0, \text{SolFinal}[2])) \\ &\text{ComprobarCuatro} := -6 \end{aligned} \quad (26)$$

$$> \text{plot}(\text{SolFinal}[1], t = 0 .. 1, y = 0 .. 15)$$



```
> plot(SolFinal[2], t=0..1, y=-10..5)
```



```
> ComprobarCinco := simplify(eval(subs(x[1](t) = SolFinal[1], x[2](t) = SolFinal[2],
lhs(Sistema[1]) - rhs(Sistema[1]) = 0)))
```

$\text{ComprobarCinco} := 0 = 0$

(27)

```
> ComprobarSeis := simplify(eval(subs(x[1](t) = SolFinal[1], x[2](t) = SolFinal[2],
lhs(Sistema[2]) - rhs(Sistema[2]) = 0)))
```

$\text{ComprobarSeis} := 0 = 0$

(28)

```
> restart
```

```
> G := \frac{s}{(2 \cdot s^2 - 4 \cdot s + 20)}
```

$G := \frac{s}{2s^2 - 4s + 20}$

(29)

```
> GG := \frac{1}{2} \cdot \left( \frac{s}{(s^2 - 2 \cdot s + 10)} \right)
```

(30)

$$GG := \frac{s}{2 (s^2 - 2 s + 10)} \quad (30)$$

$$\begin{aligned} &> GGG := \frac{1}{2} \left(\frac{s}{((s-1)^2 + 9)} \right) \\ &GGG := \frac{s}{2 ((s-1)^2 + 9)} \quad (31) \end{aligned}$$

$$\begin{aligned} &> GGGG := \frac{1}{2} \cdot \left(\frac{s}{((s-1)^2 + 3^2)} \right) \\ &GGGG := \frac{s}{2 ((s-1)^2 + 9)} \quad (32) \end{aligned}$$

$$\begin{aligned} &> GGGGG := \frac{1}{2} \cdot \left(\frac{(s-1)}{((s-1)^2 + 3^2)} \right) + \frac{1}{6} \cdot \left(\frac{3}{((s-1)^2 + 3^2)} \right) \\ &GGGGG := \frac{s-1}{2 ((s-1)^2 + 9)} + \frac{1}{2 ((s-1)^2 + 9)} \quad (33) \end{aligned}$$

$$\begin{aligned} &> \text{with(inttrans)} : \\ &> g := \text{invlaplace}(GGGGG, s, t) \\ &g := \frac{e^t (3 \cos(3 t) + \sin(3 t))}{6} \quad (34) \end{aligned}$$

$$\begin{aligned} &> gg := \text{invlaplace}(G, s, t) \\ &gg := \frac{e^t (3 \cos(3 t) + \sin(3 t))}{6} \quad (35) \end{aligned}$$

>