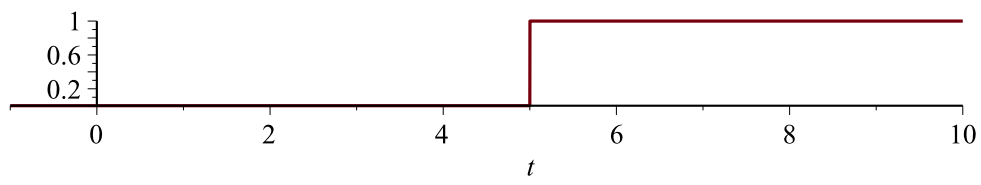


```
> restart
```

```
> plot(Heaviside( $t - 5$ ),  $t = -1 .. 10$ , scaling = CONSTRAINED)
```



```
> with(inttrans) :
```

```
> laplace(Heaviside( $t - 5$ ),  $t$ ,  $s$ )
```

$$\frac{e^{-5s}}{s}$$

(1)

```
> laplace(diff(Heaviside( $t - 5$ ),  $t$ ),  $t$ ,  $s$ )
```

$$e^{-5s}$$

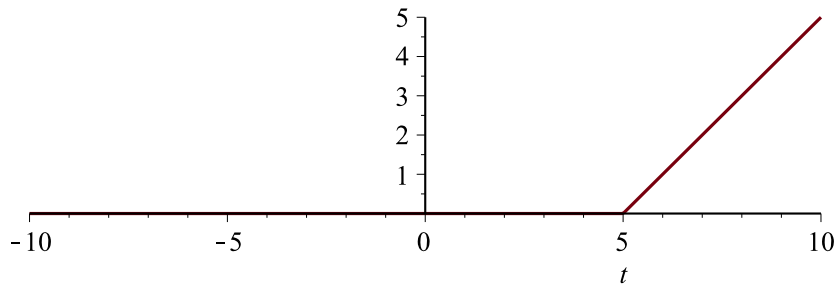
(2)

```
> laplace(Dirac( $t - 5$ ),  $t$ ,  $s$ )
```

$$e^{-5s}$$

(3)

```
> plot(Heaviside( $t - 5$ ) * ( $t - 5$ ), scaling = CONSTRAINED)
```



```
> laplace(Heaviside(t - 5) * (t - 5), t, s)
```

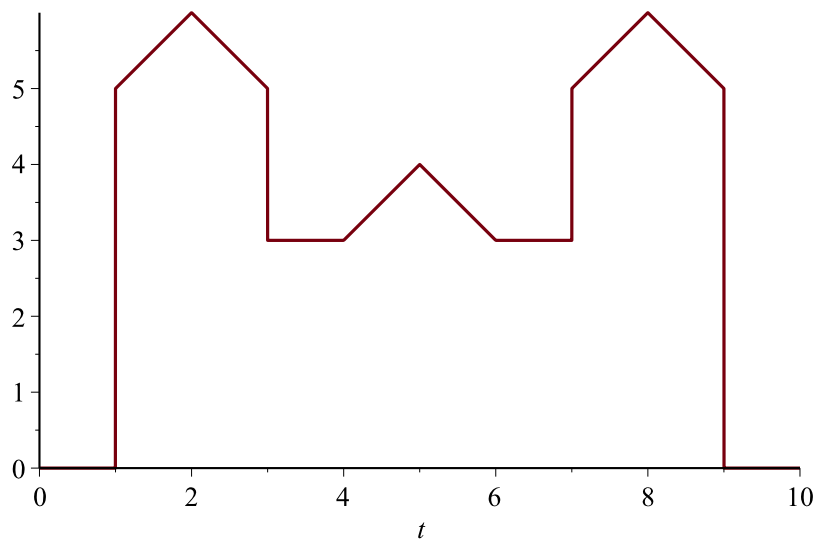
$$\frac{e^{-5s}}{s^2}$$

(4)

```
> restart
```

```
> Castillo := 5 * Heaviside(t - 1) + (t - 1) * Heaviside(t - 1) - 2 * (t - 2) * Heaviside(t - 2) + (t - 3) * Heaviside(t - 3) - 2 * Heaviside(t - 3) + (t - 4) * Heaviside(t - 4) - 2 * (t - 5) * Heaviside(t - 5) + (t - 6) * Heaviside(t - 6) + 2 * Heaviside(t - 7) + (t - 7) * Heaviside(t - 7) - 2 * (t - 8) * Heaviside(t - 8) + (t - 9) * Heaviside(t - 9) - 5 * Heaviside(t - 9);
plot(Castillo, t = 0 .. 10, scaling = CONSTRAINED)
```

```
Castillo := 5 Heaviside(t - 1) + (t - 1) Heaviside(t - 1) - 2 (t - 2) Heaviside(t - 2) + (t - 3) Heaviside(t - 3) - 2 Heaviside(t - 3) + (t - 4) Heaviside(t - 4) - 2 (t - 5) Heaviside(t - 5) + (t - 6) Heaviside(t - 6) + 2 Heaviside(t - 7) + (t - 7) Heaviside(t - 7) - 2 (t - 8) Heaviside(t - 8) + (t - 9) Heaviside(t - 9) - 5 Heaviside(t - 9)
```



```
> with(inttrans) :
```

```
> CAS(s) := simplify(laplace(Castillo, t, s))
```

$$CAS(s) = -\frac{1}{s^2} \left(e^{-s} (5 e^{-8s} s - e^{-8s} + 2 e^{-7s} - 2 e^{-6s} s - e^{-6s} - e^{-5s} + 2 e^{-4s} - e^{-3s} + 2 e^{-2s} s - e^{-2s} + 2 e^{-s} - 5 s - 1) \right) \quad (5)$$

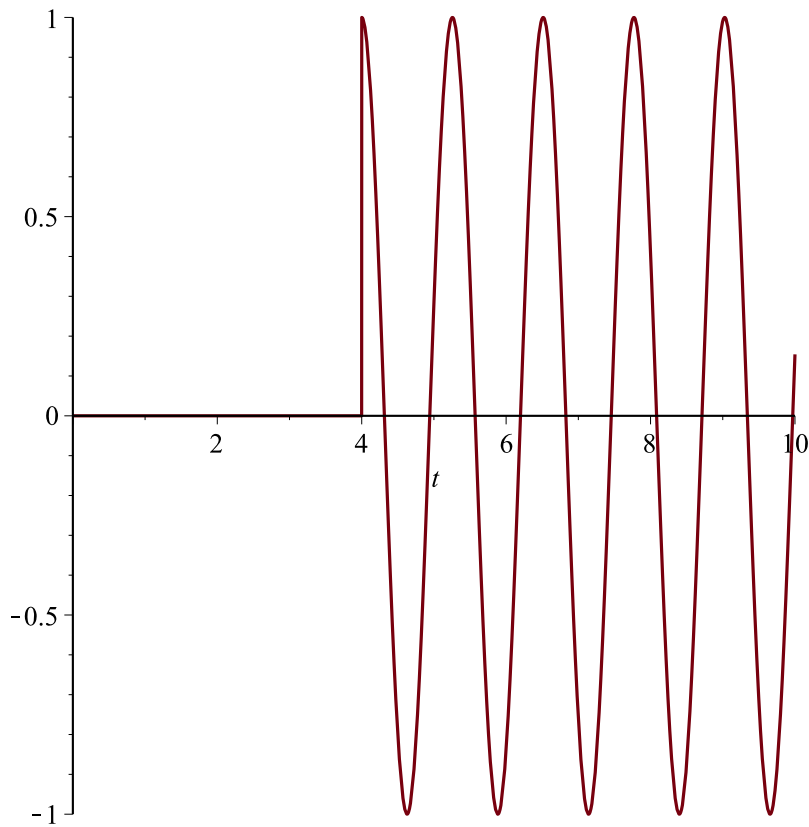
```
> EDO := diff(y(t), t$2) + 8*diff(y(t), t) - 16*y(t) = Heaviside(t-4)*cos(5*(t-4))
```

$$EDO := \frac{d^2}{dt^2} y(t) + 8 \left(\frac{d}{dt} y(t) \right) - 16 y(t) = \text{Heaviside}(t-4) \cos(5t-20) \quad (6)$$

```
> Q(t) := rhs(EDO)
```

$$Q(t) := \text{Heaviside}(t-4) \cos(5t-20) \quad (7)$$

```
> plot(Q(t), t=0..10)
```



> $cond := y(0) = 0, D(y)(0) = 5$

$$cond := y(0) = 0, D(y)(0) = 5 \quad (8)$$

> $EDOtrans := subs(cond, laplace(EDO, t, s))$

$$\begin{aligned} EDOtrans &:= s^2 laplace(y(t), t, s) - 5 + 8 s laplace(y(t), t, s) - 16 laplace(y(t), t, s) \\ &= \frac{e^{-4s} s}{s^2 + 25} \end{aligned} \quad (9)$$

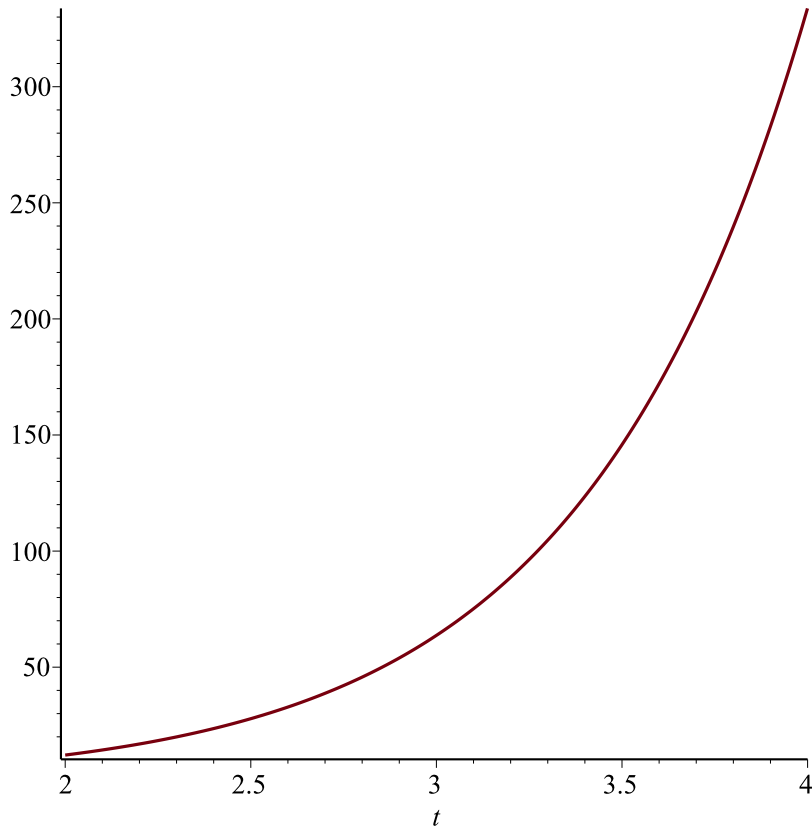
> $SOLtrans := simplify(isolate(EDOtrans, laplace(y(t), t, s)))$

$$SOLtrans := laplace(y(t), t, s) = \frac{e^{-4s} s + 5 s^2 + 125}{(s^2 + 25) (s^2 + 8 s - 16)} \quad (10)$$

> $SOLPART := invlaplace(SOLtrans, s, t)$

$$\begin{aligned} SOLPART := y(t) &= \frac{5}{8} e^{-4t} \sqrt{2} \sinh(4 t \sqrt{2}) + \frac{1}{6562} \left(-1312 \cos(t-4)^5 + 1640 \cos(t-4)^3 \right. \\ &\quad \left. - 410 \cos(t-4) + \sqrt{2} \left(41 \sqrt{2} \cosh(4 (t-4) \sqrt{2}) - 9 \sinh(4 (t-4) \sqrt{2}) \right) \right) e^{-4t+16} \\ &\quad + 80 \sin(t-4) \left((4 \cos(t-4)^2 - 1)^2 - 4 \cos(t-4)^2 \right) \\ &\quad \text{Heaviside}(t-4) \end{aligned} \quad (11)$$

```
> plot(rhs(SOLPART), t=2..4)
```



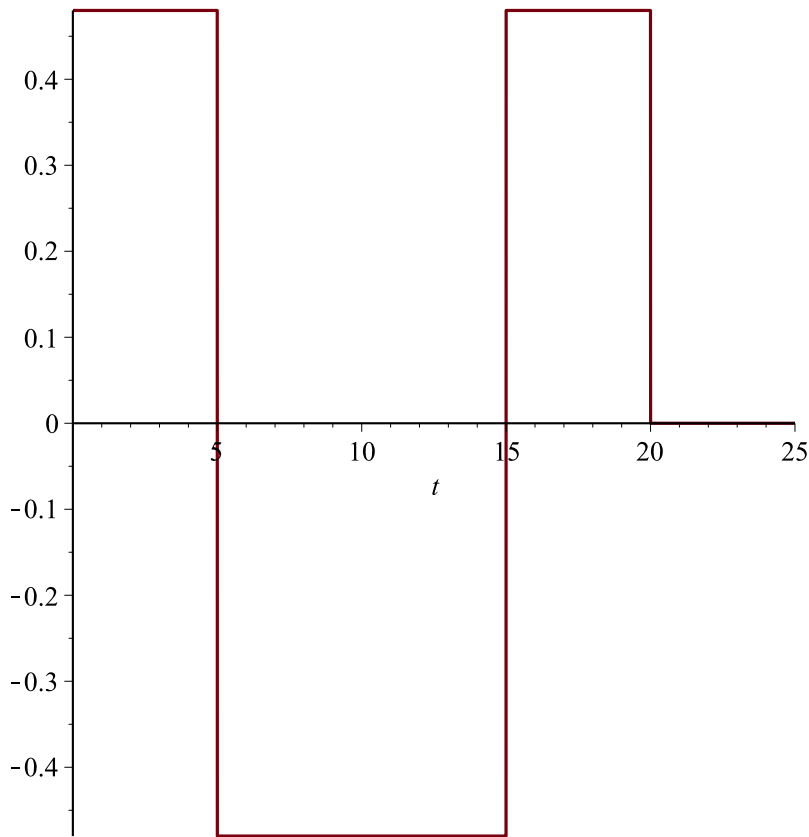
```
> restart
```

problema del elevador de la Torre Mayor

```
> Sacudida := s(t) =  $\frac{48}{100} \cdot \text{Heaviside}(t) - \frac{96}{100} \cdot \text{Heaviside}(t - a) + \frac{96}{100} \cdot \text{Heaviside}(t - 3 \cdot a)$ 
 $- \frac{48}{100} \cdot \text{Heaviside}(t - 4 \cdot a)$ 
```

```
 $Sacudida := s(t) = \frac{12}{25} \text{Heaviside}(t) - \frac{24}{25} \text{Heaviside}(t - a) + \frac{24}{25} \text{Heaviside}(t - 3 \cdot a)$ 
 $- \frac{12}{25} \text{Heaviside}(t - 4 \cdot a)$  (12)
```

```
> plot(subs(a=5, rhs(Sacudida)), t=0..25)
```



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

$$Condiciones := y(0) = 0, D(y)(0) = 0, D^{(2)}(y)(0) = 0 \quad (13)$$

> $EDO := diff(y(t), t\$3) = subs\left(a = \frac{6165}{1000}, rhs(Sacudida)\right)$

$$EDO := \frac{d^3}{dt^3} y(t) = \frac{12}{25} \text{Heaviside}(t) - \frac{24}{25} \text{Heaviside}\left(t - \frac{1233}{200}\right) + \frac{24}{25} \text{Heaviside}\left(t - \frac{3699}{200}\right) - \frac{12}{25} \text{Heaviside}\left(t - \frac{1233}{50}\right) \quad (14)$$

> $with(inttrans) :$

> $EDOtrans := subs(Condiciones, laplace(EDO, t, s))$

$$EDOtrans := s^3 \text{laplace}(y(t), t, s) = \frac{12}{25} \frac{1 - 2e^{-\frac{1233}{200}s} + 2e^{-\frac{3699}{200}s} - e^{-\frac{1233}{50}s}}{s} \quad (15)$$

> $SOLtrans := isolate(EDOtrans, laplace(y(t), t, s))$

$$SOLtrans := \text{laplace}(y(t), t, s) = \frac{12}{25} \frac{1 - 2e^{-\frac{1233}{200}s} + 2e^{-\frac{3699}{200}s} - e^{-\frac{1233}{50}s}}{s^4} \quad (16)$$

```
> SOL := invlaplace(SOLtrans, s, t)
```

$$SOL := y(t) = \frac{2}{25} t^3 - \frac{4}{25} \text{Heaviside}\left(t - \frac{1233}{200}\right) \left(t - \frac{1233}{200}\right)^3 + \frac{4}{25} \text{Heaviside}\left(t - \frac{3699}{200}\right) \left(t - \frac{3699}{200}\right)^3 - \frac{2}{25} \text{Heaviside}\left(t - \frac{1233}{50}\right) \left(t - \frac{1233}{50}\right)^3 \quad (17)$$

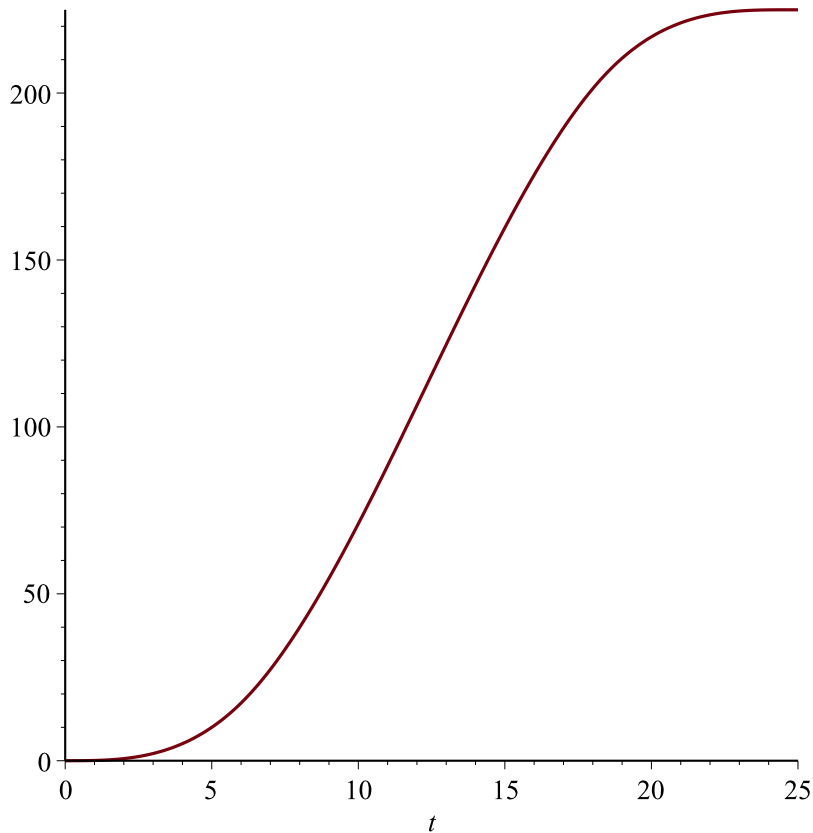
```
> TiempoFinal := evalf(4 * 6165 / 1000, 3)
```

$$TiempoFinal := 24.7 \quad (18)$$

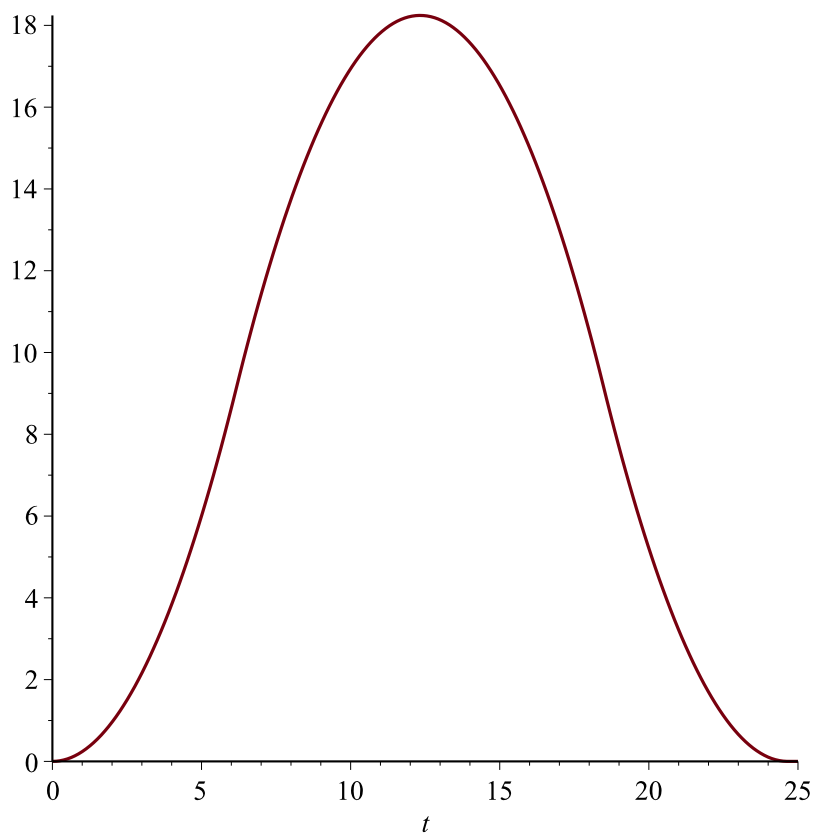
```
> Altura := evalf(subs(t = 24, SOL), 4)
```

$$Altura := y(24) = 225.0 \quad (19)$$

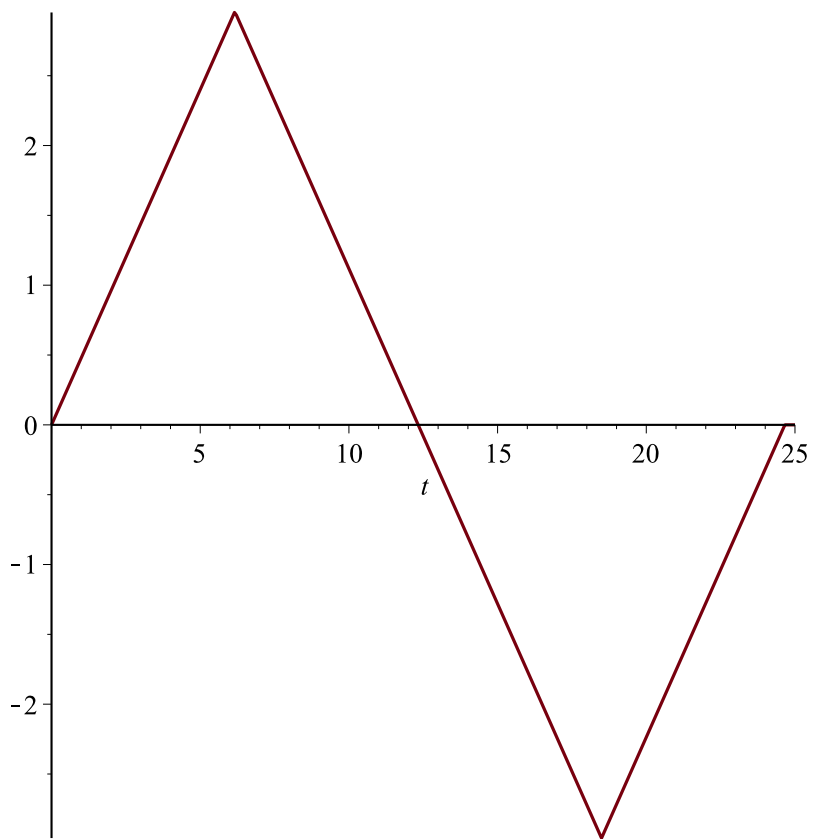
```
> plot(rhs(SOL), t = 0 .. 25)
```



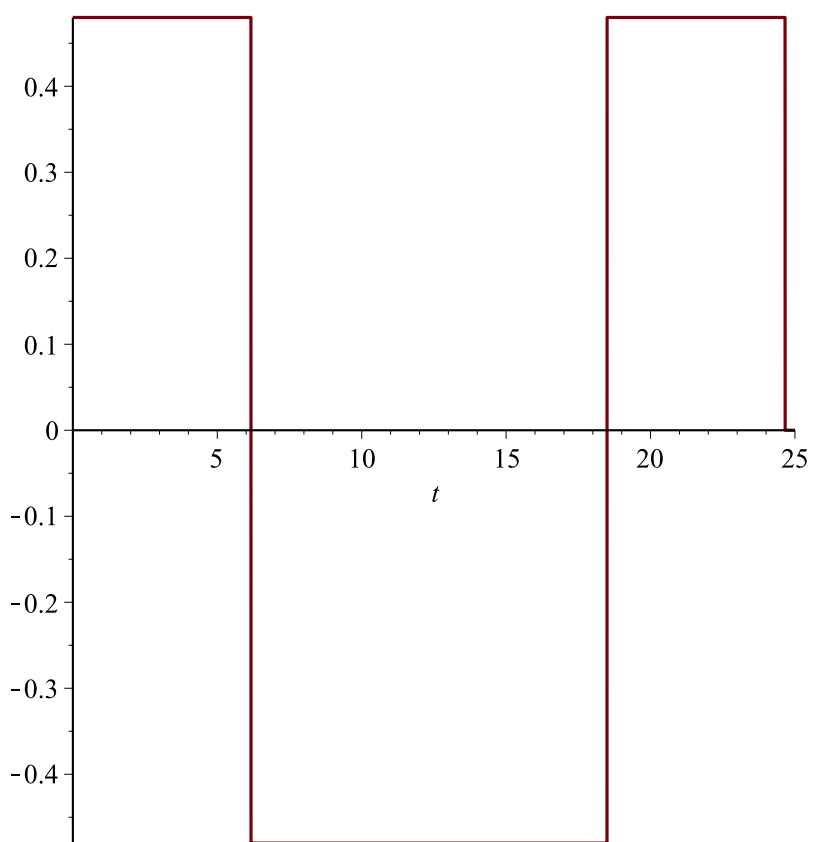
```
> plot(rhs(diff(SOL, t)), t = 0 .. 25)
```



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

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



||
||
||
||

>

>

>