```
> restart
> Sistema := diff(x[1](t), t) = x[3](t), diff(x[2](t), t) = x[4](t), diff(x[3](t), t) =
      -((k[1] + k[2])/M[1])·x[1](t) + (k[2]/M[1])·x[2](t), diff(x[4](t), t) = (k[2]/M[2])·x[1](t) - (k[2]/M[2])
      ·x[2](t) :
> Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]
```

$$\frac{d}{dt}x_1(t) = x_3(t)$$

$$\frac{d}{dt}x_2(t) = x_4(t)$$

$$\frac{d}{dt}x_3(t) = -\frac{(k_1 + k_2)\,x_1(t)}{M_1} + \frac{k_2\,x_2(t)}{M_1}$$

$$\frac{d}{dt}x_4(t) = \frac{k_2\,x_1(t)}{M_2} - \frac{k_2\,x_2(t)}{M_2} \qquad (1)$$

```
> k[1] := 6 : k[2] := 4 : M[1] := 1 : M[2] := 1 : Sistema[1]; Sistema[2]; Sistema[3];
      Sistema[4]
```

$$\frac{d}{dt}x_1(t) = x_3(t)$$

$$\frac{d}{dt}x_2(t) = x_4(t)$$

$$\frac{d}{dt}x_3(t) = -10\,x_1(t) + 4\,x_2(t)$$

$$\frac{d}{dt}x_4(t) = 4\,x_1(t) - 4\,x_2(t) \qquad (2)$$

```
> AA := matrix([[0, 0, 1, 0], [0, 0, 0, 1], [-10, 4, 0, 0], [4, -4, 0, 0]])
```

$$AA := \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -10 & 4 & 0 & 0 \\ 4 & -4 & 0 & 0 \end{bmatrix} \qquad (3)$$

```
> Xcero := array([(4/6)·(1/10), 1/10, 0, 0])
```

$$Xcero := \begin{bmatrix} \frac{1}{15} & \frac{1}{10} & 0 & 0 \end{bmatrix} \qquad (4)$$

```
> with(linalg) :
> MatExp := exponential(AA, t) : evalf(MatExp[1, 1], 3)
```

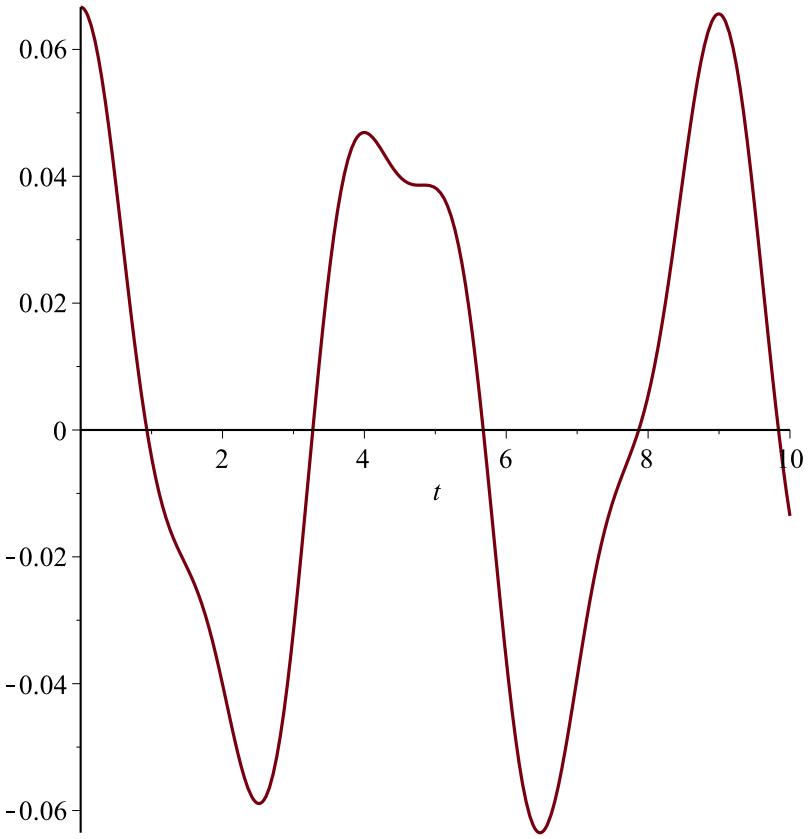
$$0.800\cos(3.46\,t) + 0.200\cos(1.41\,t) \qquad (5)$$

```
> SolPart := evalm(MatExp &* Xcero) : x[1](t) = evalf(SolPart[1], 3); x[2](t)
      = evalf(SolPart[2], 3)
```

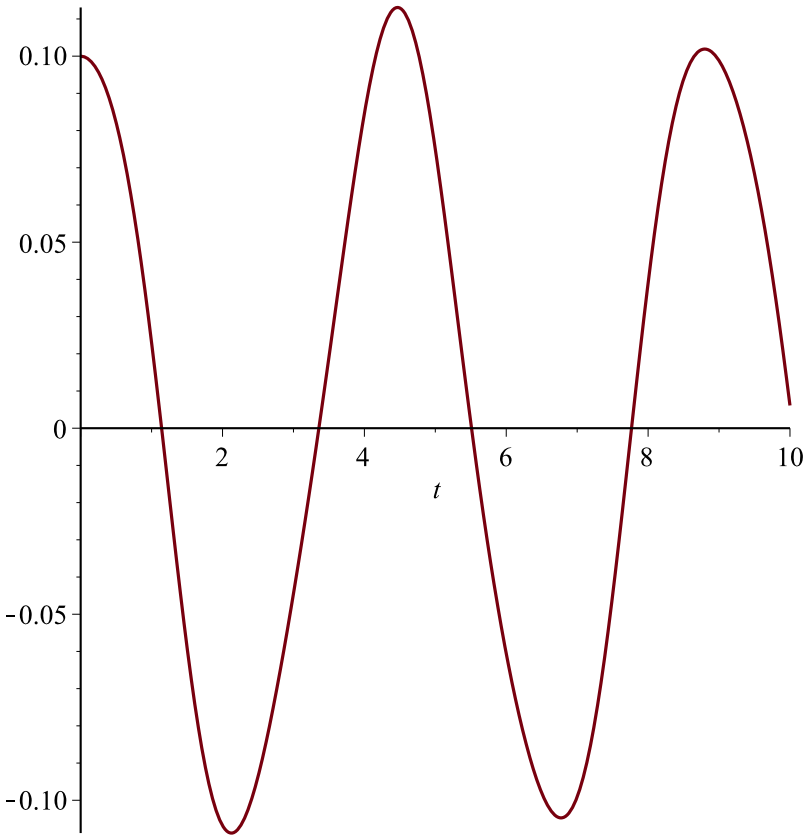
$$x_1(t) = 0.0134\cos(3.46\,t) + 0.0533\cos(1.41\,t)$$

$$x_2(t) = -0.0067\cos(3.46\,t) + 0.107\cos(1.41\,t) \qquad (6)$$

```
> plot(SolPart[1], t = 0 ..10)
```




```
> plot(SolPart[2], t = 0 ..10)
```




PRUEBA DOS

> *restart*

> $Sistema := diff(x[1](t), t) = x[3](t), diff(x[2](t), t) = x[4](t), diff(x[3](t), t) = -\frac{(k[1]+k[2])}{M[1]} \cdot x[1](t) + \frac{k[2]}{M[1]} \cdot x[2](t), diff(x[4](t), t) = \frac{k[2]}{M[2]} \cdot x[1](t) - \frac{k[2]}{M[2]} \cdot x[2](t)$ :

> $Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]$

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\frac{d}{dt} x_3(t) = -\frac{(k_1 + k_2)\, x_1(t)}{M_1} + \frac{k_2\, x_2(t)}{M_1}$$

$$\frac{d}{dt} x_4(t) = \frac{k_2\, x_1(t)}{M_2} - \frac{k_2\, x_2(t)}{M_2} \qquad \textbf{(7)}$$

> $k[1] := 4 : k[2] := 6 : M[1] := 1 : M[2] := 1 : Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]$

$$\frac{d}{dt}x_1(t) = x_3(t)$$

$$\frac{d}{dt}x_2(t) = x_4(t)$$

$$\frac{d}{dt}x_3(t) = -10\,x_1(t) + 6\,x_2(t)$$

$$\frac{d}{dt}x_4(t) = 6\,x_1(t) - 6\,x_2(t) \quad \textbf{(8)}$$

> $AA := matrix([[0, 0, 1, 0], [0, 0, 0, 1], [-10, 4, 0, 0], [4, -4, 0, 0]])$

$$AA := \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -10 & 4 & 0 & 0 \\ 4 & -4 & 0 & 0 \end{bmatrix} \quad \textbf{(9)}$$

> $Xcero := array\left(\left[\frac{6}{4}\cdot\frac{1}{10}, \frac{1}{10}, 0, 0\right]\right)$

$$Xcero := \begin{bmatrix} \frac{3}{20} & \frac{1}{10} & 0 & 0 \end{bmatrix} \quad \textbf{(10)}$$

> $with(linalg)$ :

> $MatExp := exponential(AA, t)$ : $evalf(MatExp[1, 1], 3)$

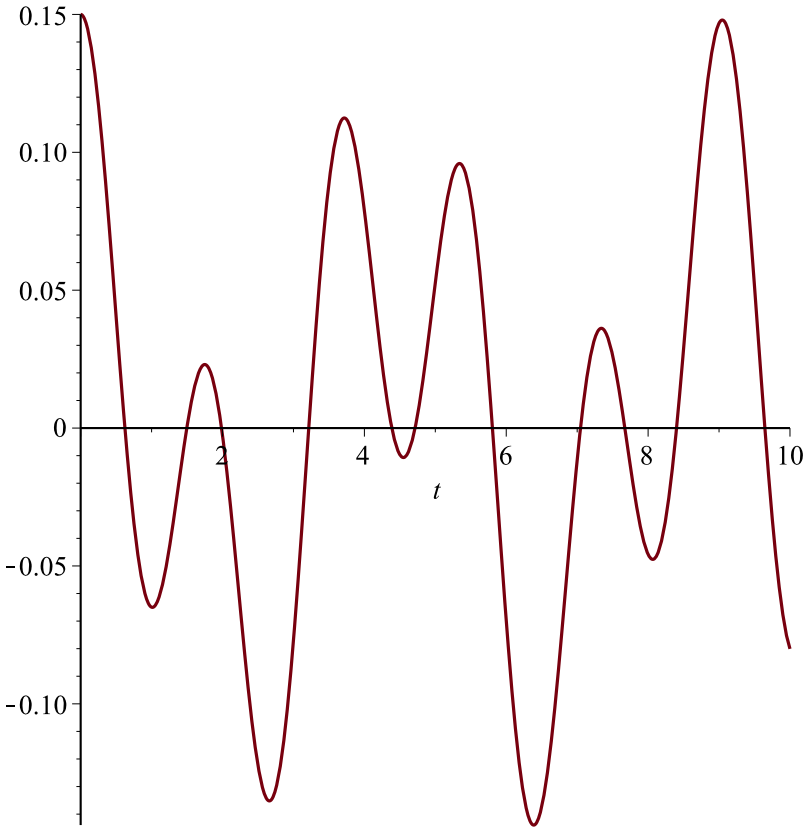
$$0.800\cos(3.46\,t) + 0.200\cos(1.41\,t) \quad \textbf{(11)}$$

> $SolPart := evalm(MatExp \&* Xcero)$ : $x[1](t) = evalf(SolPart[1], 3)$; $x[2](t) = evalf(SolPart[2], 3)$

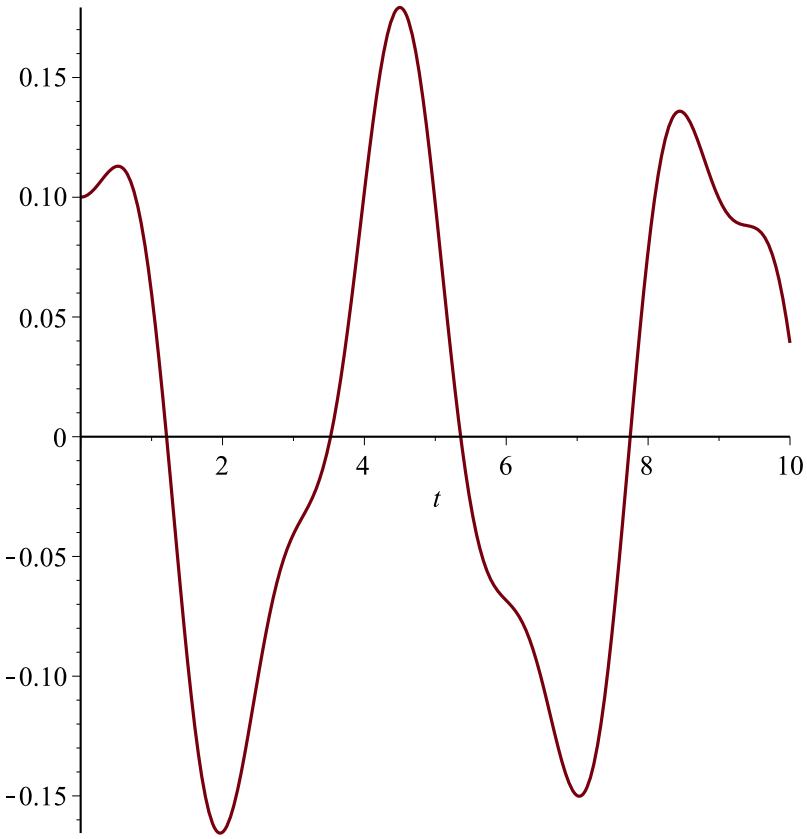
$$x_1(t) = 0.0800\cos(3.46\,t) + 0.0700\cos(1.41\,t)$$

$$x_2(t) = -0.0400\cos(3.46\,t) + 0.140\cos(1.41\,t) \quad \textbf{(12)}$$

> $plot(SolPart[1], t = 0..10)$




> $plot(SolPart[2], t = 0..10)$




PRUEBA TRES

> *restart*

> $Sistema := diff(x[1](t), t) = x[3](t), diff(x[2](t), t) = x[4](t), diff(x[3](t), t) = -\frac{(k[1]+k[2])}{M[1]} \cdot x[1](t) + \frac{k[2]}{M[1]} \cdot x[2](t), diff(x[4](t), t) = \frac{k[2]}{M[2]} \cdot x[1](t) - \frac{k[2]}{M[2]} \cdot x[2](t)$ :

> $Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]$

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\frac{d}{dt} x_3(t) = -\frac{(k_1 + k_2)\, x_1(t)}{M_1} + \frac{k_2\, x_2(t)}{M_1}$$

$$\frac{d}{dt} x_4(t) = \frac{k_2\, x_1(t)}{M_2} - \frac{k_2\, x_2(t)}{M_2} \quad \textbf{(13)}$$

> $k[1] := 6 : k[2] := 4 : M[1] := 1 : M[2] := \frac{3}{2} : Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]$

$$\frac{d}{dt}x_1(t) = x_3(t)$$

$$\frac{d}{dt}x_2(t) = x_4(t)$$

$$\frac{d}{dt}x_3(t) = -10\,x_1(t) + 4\,x_2(t)$$

$$\frac{d}{dt}x_4(t) = \frac{8}{3}\,x_1(t) - \frac{8}{3}\,x_2(t) \quad \textbf{(14)}$$

> $AA := matrix([[0, 0, 1, 0], [0, 0, 0, 1], [-10, 4, 0, 0], [4, -4, 0, 0]])$

$$AA := \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -10 & 4 & 0 & 0 \\ 4 & -4 & 0 & 0 \end{bmatrix} \quad \textbf{(15)}$$

> $Xcero := array\left(\left[\frac{4}{6}\cdot\frac{1}{10}, \frac{1}{10}, 0, 0\right]\right)$

$$Xcero := \begin{bmatrix} \frac{1}{15} & \frac{1}{10} & 0 & 0 \end{bmatrix} \quad \textbf{(16)}$$

> $with(linalg)$ :

> $MatExp := exponential(AA, t)$ : $evalf(MatExp[1, 1], 3)$

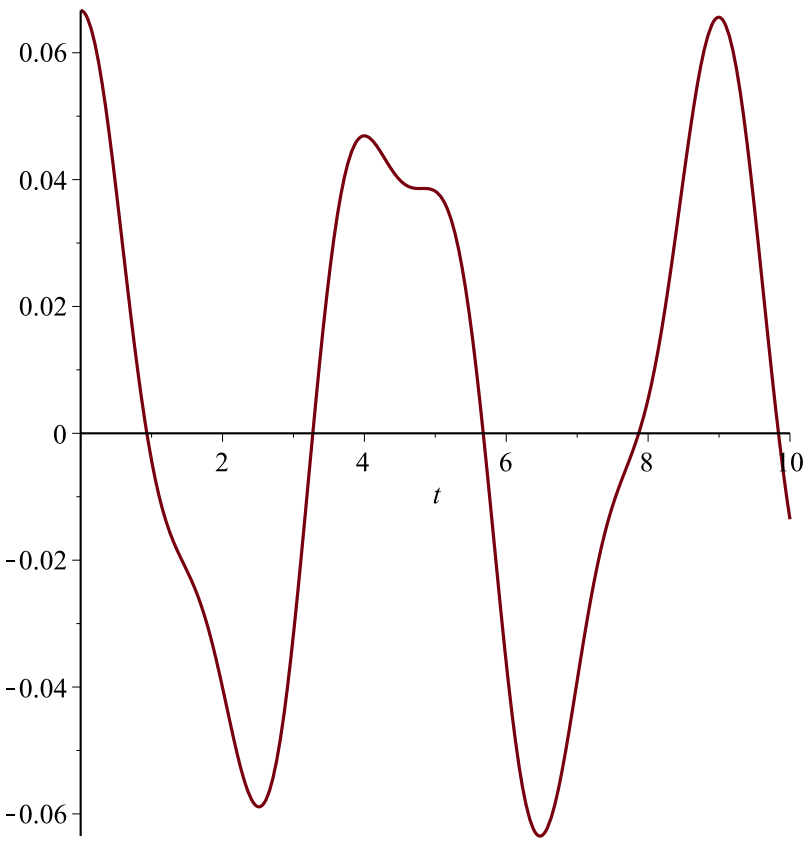
$$0.800\cos(3.46\,t) + 0.200\cos(1.41\,t) \quad \textbf{(17)}$$

> $SolPart := evalm(MatExp \&* Xcero)$ : $x[1](t) = evalf(SolPart[1], 3)$; $x[2](t) = evalf(SolPart[2], 3)$

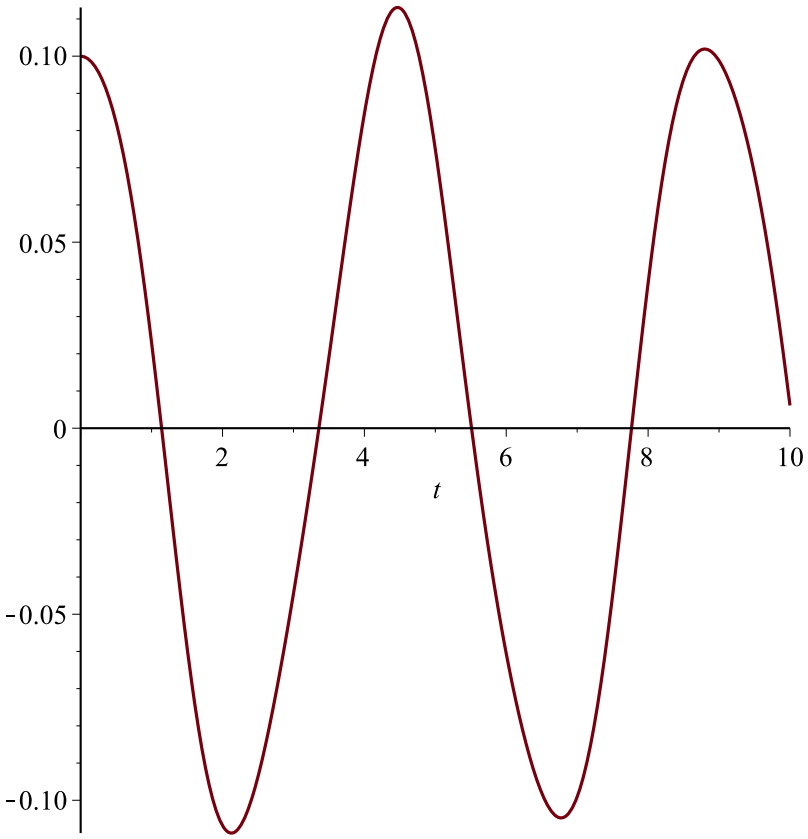
$$x_1(t) = 0.0134\cos(3.46\,t) + 0.0533\cos(1.41\,t)$$

$$x_2(t) = -0.0067\cos(3.46\,t) + 0.107\cos(1.41\,t) \quad \textbf{(18)}$$

> $plot(SolPart[1], t = 0..10)$




> $plot(SolPart[2], t = 0..10)$




PRUEBA CUATRO

> *restart*

> $Sistema := diff(x[1](t), t) = x[3](t), diff(x[2](t), t) = x[4](t), diff(x[3](t), t) = -\frac{(k[1]+k[2])}{M[1]} \cdot x[1](t) + \frac{k[2]}{M[1]} \cdot x[2](t), diff(x[4](t), t) = \frac{k[2]}{M[2]} \cdot x[1](t) - \frac{k[2]}{M[2]} \cdot x[2](t)$ :

> $Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]$

$$\frac{d}{dt} x_1(t) = x_3(t)$$

$$\frac{d}{dt} x_2(t) = x_4(t)$$

$$\frac{d}{dt} x_3(t) = -\frac{(k_1 + k_2)\, x_1(t)}{M_1} + \frac{k_2\, x_2(t)}{M_1}$$

$$\frac{d}{dt} x_4(t) = \frac{k_2\, x_1(t)}{M_2} - \frac{k_2\, x_2(t)}{M_2} \qquad \textbf{(19)}$$

> $k[1] := 4 : k[2] := 6 : M[1] := 1 : M[2] := \frac{3}{2} : Sistema[1]; Sistema[2]; Sistema[3]; Sistema[4]$

$$\frac{d}{dt}x_1(t) = x_3(t)$$

$$\frac{d}{dt}x_2(t) = x_4(t)$$

$$\frac{d}{dt}x_3(t) = -10\,x_1(t) + 6\,x_2(t)$$

$$\frac{d}{dt}x_4(t) = 4\,x_1(t) - 4\,x_2(t) \quad \textbf{(20)}$$

```
> AA := matrix([[0, 0, 1, 0], [0, 0, 0, 1], [-10, 4, 0, 0], [4, -4, 0, 0]])
```

$$AA := \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -10 & 4 & 0 & 0 \\ 4 & -4 & 0 & 0 \end{bmatrix} \quad \textbf{(21)}$$

```
> Xcero := array([6/4 . 1/10, 1/10, 0, 0])
```

$$Xcero := \begin{bmatrix} \frac{3}{20} & \frac{1}{10} & 0 & 0 \end{bmatrix} \quad \textbf{(22)}$$

```
> with(linalg) :
> MatExp := exponential(AA, t) : evalf(MatExp[1, 1], 3)
```

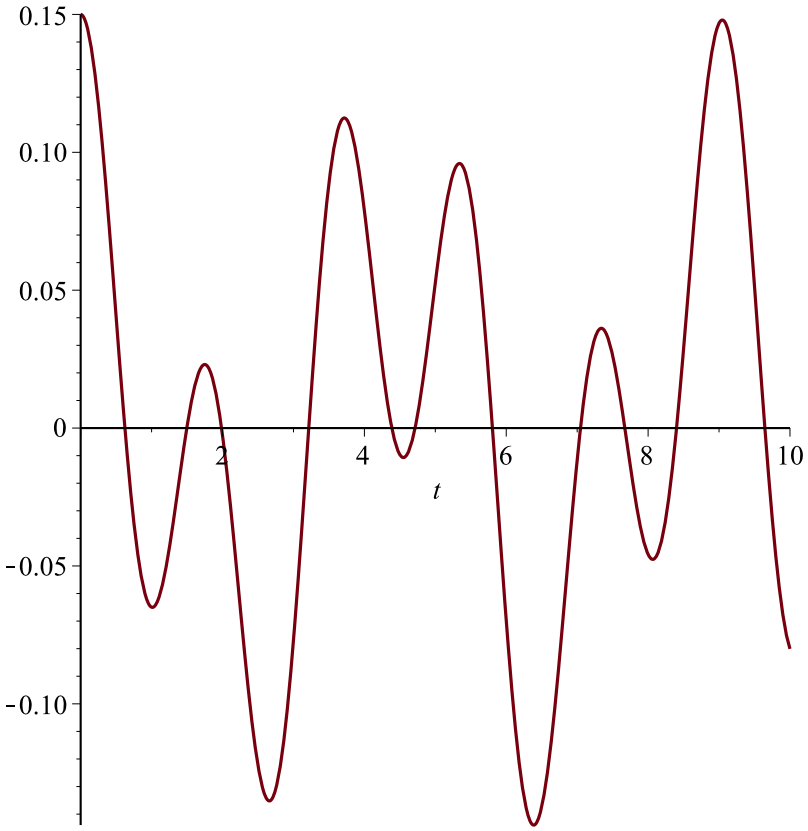
$$0.800\cos(3.46\,t) + 0.200\cos(1.41\,t) \quad \textbf{(23)}$$

```
> SolPart := evalm(MatExp &* Xcero) : x[1](t) = evalf(SolPart[1], 3); x[2](t)
      = evalf(SolPart[2], 3)
```

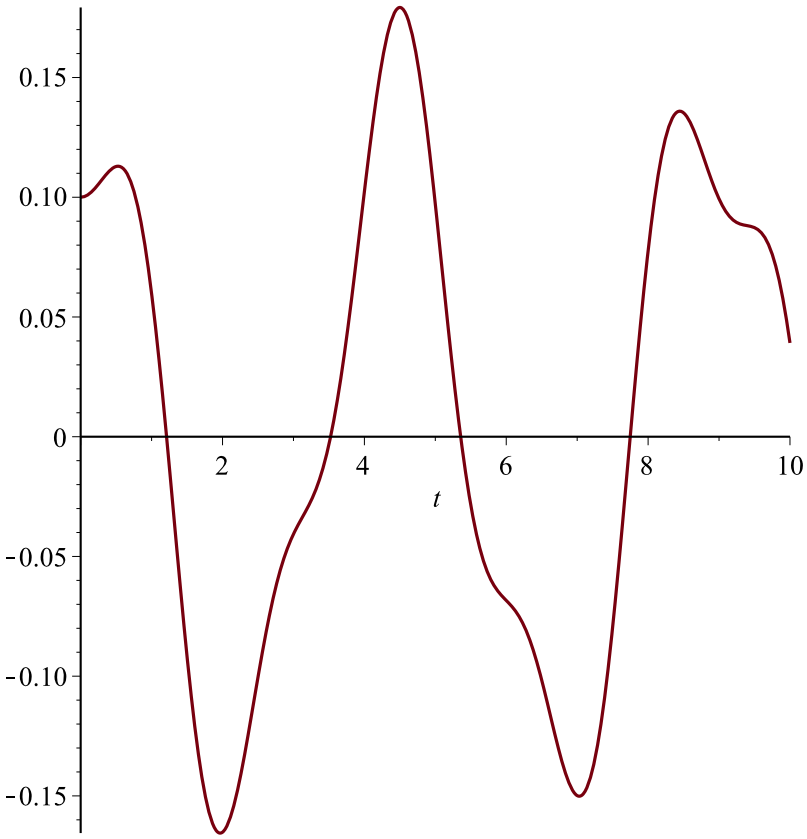
$$x_1(t) = 0.0800\cos(3.46\,t) + 0.0700\cos(1.41\,t)$$

$$x_2(t) = -0.0400\cos(3.46\,t) + 0.140\cos(1.41\,t) \quad \textbf{(24)}$$

```
> plot(SolPart[1], t = 0..10)
```




> $plot(SolPart[2], t = 0..10)$




> *restart*

> $Sistema := diff(i[1](t), t) + 50 \cdot i[1](t) = 60, \frac{50}{10000} \cdot diff(i[2](t), t) + i[2](t) - i[1](t) = 0$ :

*Sistema*[1]; *Sistema*[2];

$$\frac{d}{dt} i_1(t) + 50\, i_1(t) = 60$$

$$\frac{1}{200} \frac{d}{dt} i_2(t) + i_2(t) - i_1(t) = 0 \quad \textbf{(25)}$$

> $Cond := i[1](0) = 0, i[2](0) = 0$

$$Cond := i_1(0) = 0, i_2(0) = 0 \quad \textbf{(26)}$$

> *with*(*inttrans*) :

> $SistTransLap := subs(Cond, laplace(\{Sistema\}, t, s))$

$$SistTransLap := \left\{ s\, laplace\left(i_1(t), t, s\right) + 50\, laplace\left(i_1(t), t, s\right) = \frac{60}{s}, \frac{1}{200} s\, laplace\left(i_2(t), t, s\right) + laplace\left(i_2(t), t, s\right) - laplace\left(i_1(t), t, s\right) = 0 \right\} \quad \textbf{(27)}$$

> $SolUno := isolate(SistTransLap[1], laplace(i[1](t), t, s))$

**(28)**

$$SolUno := laplace\left(i_1(t), t, s\right) = \frac{60}{s\,(s+50)} \tag{28}$$

```
> SolDos := isolate(subs(laplace(i[1](t), t, s) = rhs(SolUno), SistTransLap[2]),
      laplace(i[2](t), t, s))
```

$$SolDos := laplace\left(i_2(t), t, s\right) = \frac{60}{s\,(s+50)\left(\frac{1}{200}\,s+1\right)} \tag{29}$$

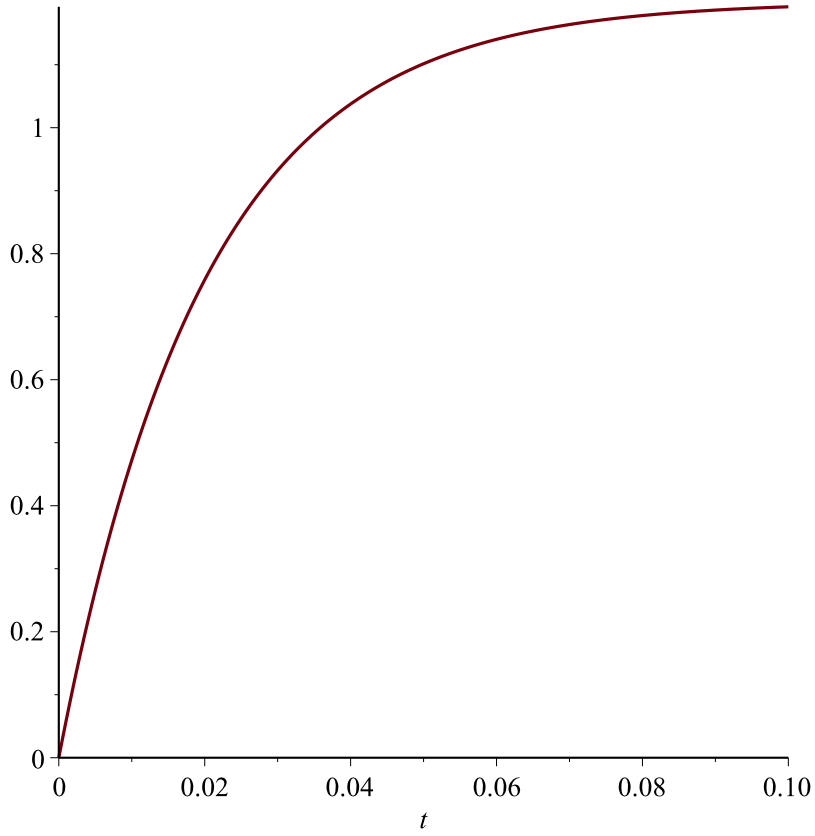
```
> SolPartUno := invlaplace(SolUno, s, t)
```

$$SolPartUno := i_1(t) = \frac{6}{5} - \frac{6}{5}\,e^{-50\,t} \tag{30}$$

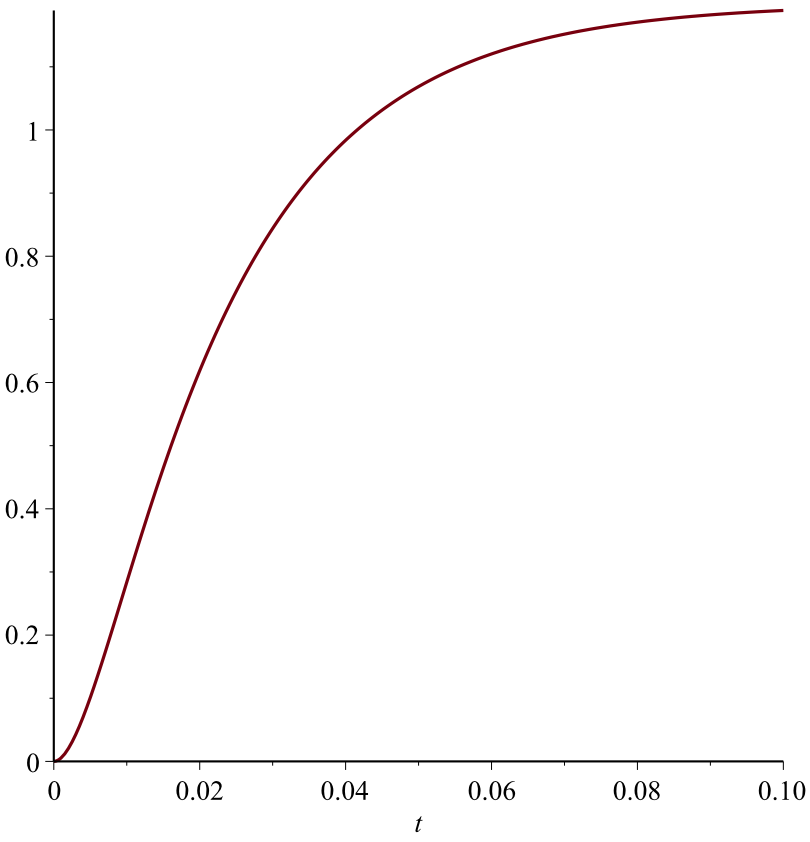
```
> SolPartDos := invlaplace(SolDos, s, t)
```

$$SolPartDos := i_2(t) = \frac{2}{5}\,e^{-200\,t} + \frac{6}{5} - \frac{8}{5}\,e^{-50\,t} \tag{31}$$

```
> plot(rhs(SolPartUno), t = 0..0.1)
```




```
> plot(rhs(SolPartDos), t = 0..0.1)
```


1
0.8
0.6
0.4
0.2
0
0
0.02
0.04
0.06
0.08
0.10
t