

```
> restart
```

```
> Sistema := diff(x[1](t), t) = x[3](t), diff(x[2](t), t) = x[4](t), diff(x[3](t), t) = -10·x[1](t)
+ 4·x[2](t), diff(x[4](t), t) = 4·x[1](t) - 4·x[2](t) : Sistema[1]; Sistema[2];
Sistema[3]; Sistema[4];
```

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

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

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

$$\frac{d}{dt} x_4(t) = 4 x_1(t) - 4 x_2(t) \quad (1)$$

```
> CondIni := x[1](0) = 3/20, x[2](0) = 1/10, x[3](0) = 0, x[4](0) = 0
```

$$CondIni := x_1(0) = \frac{3}{20}, x_2(0) = \frac{1}{10}, x_3(0) = 0, x_4(0) = 0 \quad (2)$$

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

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

```
> Xcero := array([ [3/20, 1/10, 0, 0] ])
```

$$Xcero := \begin{bmatrix} \frac{3}{20} & \frac{1}{10} & 0 & 0 \end{bmatrix} \quad (4)$$

```
>
```

SOLUCION

```
> with(linalg) :
```

```
> MatExp := exponential(AA, t) : MatExp[1, 1]; evalf(%, 2); MatExp[4, 4]; evalf(%, 2)
```

$$\frac{2 \cos(\sqrt{2} t) + 8 \cos(2 \sqrt{3} t)}{(2 \sqrt{3} + \sqrt{2}) (2 \sqrt{3} - \sqrt{2})}$$

$$0.20 \cos(1.4 t) + 0.80 \cos(3.4 t)$$

$$\frac{8 \cos(\sqrt{2} t) + 2 \cos(2 \sqrt{3} t)}{(2 \sqrt{3} + \sqrt{2}) (2 \sqrt{3} - \sqrt{2})}$$

$$0.80 \cos(1.4 t) + 0.20 \cos(3.4 t) \quad (5)$$

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

$$x_1(t) = \frac{3 (2 \cos(\sqrt{2} t) + 8 \cos(2 \sqrt{3} t))}{20 (2 \sqrt{3} + \sqrt{2}) (2 \sqrt{3} - \sqrt{2})} + \frac{-4 \cos(2 \sqrt{3} t) + 4 \cos(\sqrt{2} t)}{10 (2 \sqrt{3} + \sqrt{2}) (2 \sqrt{3} - \sqrt{2})}$$

$$x_1(t) = 0.070 \cos(1.4 t) + 0.080 \cos(3.4 t) \quad (6)$$

> $x[2](t) = \text{SolPart}[2]; \text{evalf}(\%, 2)$

$$x_2(t) = \frac{3(-4 \cos(2\sqrt{3} t) + 4 \cos(\sqrt{2} t))}{20(2\sqrt{3} + \sqrt{2})(2\sqrt{3} - \sqrt{2})} + \frac{8 \cos(\sqrt{2} t) + 2 \cos(2\sqrt{3} t)}{10(2\sqrt{3} + \sqrt{2})(2\sqrt{3} - \sqrt{2})}$$

$$x_2(t) = -0.040 \cos(3.4 t) + 0.14 \cos(1.4 t) \quad (7)$$

> $x[3](t) = \text{SolPart}[3]; \text{evalf}(\%, 2)$

$$x_3(t) = \frac{3(-2\sqrt{2} \sin(\sqrt{2} t) - 16\sqrt{3} \sin(2\sqrt{3} t))}{20(2\sqrt{3} + \sqrt{2})(2\sqrt{3} - \sqrt{2})}$$

$$+ \frac{-4\sqrt{2} \sin(\sqrt{2} t) + 8\sqrt{3} \sin(2\sqrt{3} t)}{10(2\sqrt{3} + \sqrt{2})(2\sqrt{3} - \sqrt{2})}$$

$$x_3(t) = -0.098 \sin(1.4 t) - 0.26 \sin(3.4 t) \quad (8)$$

> $x[4](t) = \text{SolPart}[4]; \text{evalf}(\%, 2)$

$$x_4(t) = \frac{3(-4\sqrt{2} \sin(\sqrt{2} t) + 8\sqrt{3} \sin(2\sqrt{3} t))}{20(2\sqrt{3} + \sqrt{2})(2\sqrt{3} - \sqrt{2})}$$

$$+ \frac{-8\sqrt{2} \sin(\sqrt{2} t) - 4\sqrt{3} \sin(2\sqrt{3} t)}{10(2\sqrt{3} + \sqrt{2})(2\sqrt{3} - \sqrt{2})}$$

$$x_4(t) = -0.19 \sin(1.4 t) + 0.14 \sin(3.4 t) \quad (9)$$

> $\text{ComprobarUno} := \text{eval}(\text{subs}(x[1](t) = \text{SolPart}[1], x[3](t) = \text{SolPart}[3], \text{lhs}(\text{Sistema}[1]) - \text{rhs}(\text{Sistema}[1]) = 0))$

$$\text{ComprobarUno} := 0 = 0 \quad (10)$$

> $\text{ComprobarDos} := \text{eval}(\text{subs}(x[2](t) = \text{SolPart}[2], x[4](t) = \text{SolPart}[4], \text{lhs}(\text{Sistema}[2]) - \text{rhs}(\text{Sistema}[2]) = 0))$

$$\text{ComprobarDos} := 0 = 0 \quad (11)$$

> $\text{ComprobarTres} := \text{simplify}(\text{eval}(\text{subs}(x[1](t) = \text{SolPart}[1], x[2](t) = \text{SolPart}[2], x[3](t) = \text{SolPart}[3], x[4](t) = \text{SolPart}[4], \text{lhs}(\text{Sistema}[3]) - \text{rhs}(\text{Sistema}[3]) = 0)))$

$$\text{ComprobarTres} := 0 = 0 \quad (12)$$

> $\text{ComprobarCuatro} := \text{simplify}(\text{eval}(\text{subs}(x[1](t) = \text{SolPart}[1], x[2](t) = \text{SolPart}[2], x[3](t) = \text{SolPart}[3], x[4](t) = \text{SolPart}[4], \text{lhs}(\text{Sistema}[4]) - \text{rhs}(\text{Sistema}[4]) = 0)))$

$$\text{ComprobarCuatro} := 0 = 0 \quad (13)$$

> CondIni

$$x_1(0) = \frac{3}{20}, x_2(0) = \frac{1}{10}, x_3(0) = 0, x_4(0) = 0 \quad (14)$$

> $\text{ComprobarCinco} := x[1](0) = \text{simplify}(\text{subs}(t = 0, \text{SolPart}[1]))$

$$\text{ComprobarCinco} := x_1(0) = \frac{3}{20} \quad (15)$$

> $\text{ComprobarSeis} := x[2](0) = \text{simplify}(\text{subs}(t = 0, \text{SolPart}[2]))$

$$\text{ComprobarSeis} := x_2(0) = \frac{1}{10} \quad (16)$$

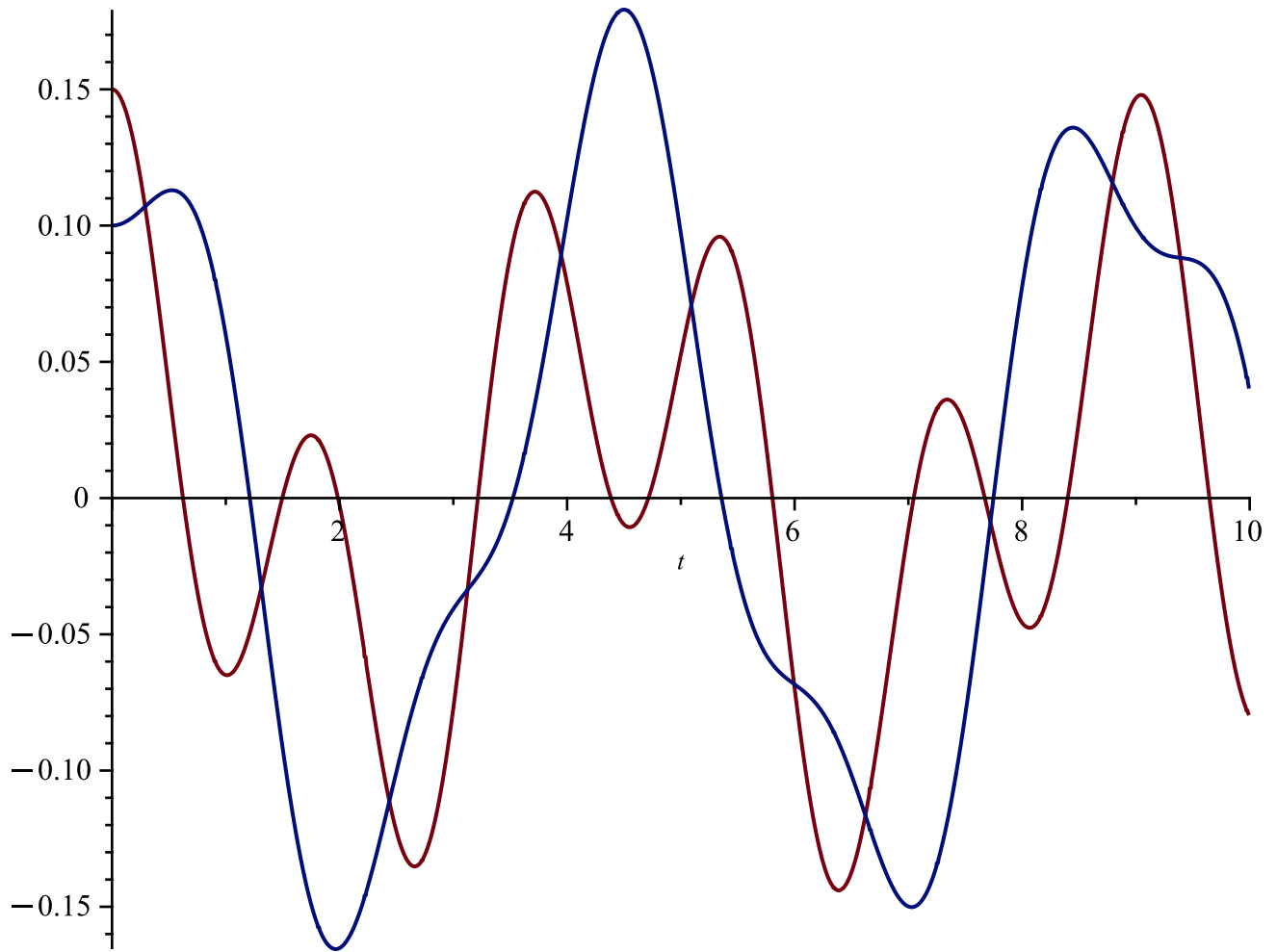
> *ComprobarSiete* := $x[3](0) = \text{simplify}(\text{subs}(t=0, \text{SolPart}[3]))$
 $\text{ComprobarSiete} := x_3(0) = 0$ (17)

> *ComprobarOcho* := $x[4](0) = \text{simplify}(\text{subs}(t=0, \text{SolPart}[4]))$
 $\text{ComprobarOcho} := x_4(0) = 0$ (18)

> $x[1](t) = \text{evalf}(\text{SolPart}[1], 2)$
 $x_1(t) = 0.070 \cos(1.4 t) + 0.080 \cos(3.4 t)$ (19)

> $x[2](t) = \text{evalf}(\text{SolPart}[2], 2)$
 $x_2(t) = -0.040 \cos(3.4 t) + 0.14 \cos(1.4 t)$ (20)

> $\text{plot}(\{\text{SolPart}[1], \text{SolPart}[2]\}, t=0..10)$



> *restart*

> *Sistema* := $\text{diff}(i[1](t), t) = 50 \cdot i[2](t) + 60, \text{diff}(i[2](t), t) = \frac{1000}{5} \cdot i[1](t) - \frac{1000}{5}$
 $\cdot i[2](t) : \text{Sistema}[1]; \text{Sistema}[2]$
 $\frac{d}{dt} i_1(t) = 50 i_2(t) + 60$
 $\frac{d}{dt} i_2(t) = 200 i_1(t) - 200 i_2(t)$ (21)

$$\begin{aligned} > \text{ConIni} := i[1](0) = 0, i[2](0) = 0 \\ & \text{ConIni} := i_1(0) = 0, i_2(0) = 0 \end{aligned} \quad (22)$$

$$\begin{aligned} > AA := \text{array}([[0, 50], [200, -200]]) \\ & AA := \begin{bmatrix} 0 & 50 \\ 200 & -200 \end{bmatrix} \end{aligned} \quad (23)$$

$$\begin{aligned} > Xcero := \text{array}([0, 0]) \\ & Xcero := \begin{bmatrix} 0 & 0 \end{bmatrix} \end{aligned} \quad (24)$$

$$\begin{aligned} > BBtau := \text{array}([60, 0]) \\ & BBtau := \begin{bmatrix} 60 & 0 \end{bmatrix} \end{aligned} \quad (25)$$

$$\begin{aligned} > \text{with}(\text{linalg}) : \\ > \text{MatExp} := \text{exponential}(AA, t) : \text{evalf}(\text{MatExp}[1, 1], 3) \\ & 0.148 e^{-241. t} + 0.852 e^{41.0 t} \end{aligned} \quad (26)$$

$$\begin{aligned} > \text{MatExpTau} := \text{map}(\text{rccurry}(\text{eval}, t = t - \text{tau}'), \text{MatExp}) : \\ > \text{ProdTau} := \text{evalm}(\text{MatExpTau} \&* BBtau) : \text{evalf}(\text{ProdTau}[1], 3) \\ & 8.8 e^{-241. t + 241. \tau} + 51.2 e^{41.0 t - 41.0 \tau} \end{aligned} \quad (27)$$

$$\begin{aligned} > \text{SolPartNoHom} := \text{map}(\text{int}, \text{ProdTau}, \text{tau} = 0 .. t) : i[1](t) = \text{evalf}(\text{SolPartNoHom}[1], 3); \\ & i[2](t) = \text{evalf}(\text{SolPartNoHom}[2], 3) \\ & i_1(t) = -1.20 + 1.23 e^{41.0 t} - 0.034 e^{-241. t} \\ & i_2(t) = -1.20 + 1.02 e^{41.0 t} + 0.177 e^{-241. t} \end{aligned} \quad (28)$$

$$\begin{aligned} > \text{ComprobarUno} := \text{simplify}(\text{eval}(\text{subs}(i[1](t) = \text{SolPartNoHom}[1], i[2](t) \\ & = \text{SolPartNoHom}[2], \text{lhs}(\text{Sistema}[1]) - \text{rhs}(\text{Sistema}[1]) = 0))) \\ & \text{ComprobarUno} := 0 = 0 \end{aligned} \quad (29)$$

$$\begin{aligned} > \text{ComprobarDos} := \text{simplify}(\text{eval}(\text{subs}(i[1](t) = \text{SolPartNoHom}[1], i[2](t) \\ & = \text{SolPartNoHom}[2], \text{lhs}(\text{Sistema}[2]) - \text{rhs}(\text{Sistema}[2]) = 0))) \\ & \text{ComprobarDos} := 0 = 0 \end{aligned} \quad (30)$$

$$\begin{aligned} > \text{ComprobarTres} := i[1](0) = \text{simplify}(\text{subs}(t = 0, \text{SolPartNoHom}[1])) \\ & \text{ComprobarTres} := i_1(0) = 0 \end{aligned} \quad (31)$$

$$\begin{aligned} > \text{ComprobarCuatro} := i[2](0) = \text{simplify}(\text{subs}(t = 0, \text{SolPartNoHom}[2])) \\ & \text{ComprobarCuatro} := i_2(0) = 0 \end{aligned} \quad (32)$$

> |