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> restart
> Sistema := diff(x[1](t), t) = x[1](t) + 2·x[2](t), diff(x[2](t), t) = 3·x[1](t) + 4·x[2](t) :
Sistema[1]; Sistema[2]
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$$\begin{aligned}\frac{d}{dt} x_1(t) &= x_1(t) + 2 x_2(t) \\ \frac{d}{dt} x_2(t) &= 3 x_1(t) + 4 x_2(t)\end{aligned}\quad (1)$$

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> AA := array([[1, 2], [3, 4]])
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$$AA := \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\quad (2)$$

```
> II := array([[1, 0], [0, 1]])
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$$II := \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\quad (3)$$

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> with(linalg) :
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> EcuaCarac := det(AA - lambda·II) = 0
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$$EcuaCarac := \lambda^2 - 5\lambda - 2 = 0\quad (4)$$

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> Raiz := solve(EcuaCarac)
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$$Raiz := \frac{5}{2} + \frac{\sqrt{33}}{2}, \frac{5}{2} - \frac{\sqrt{33}}{2}\quad (5)$$

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> EcuaMat[1] := exp(Raiz[1]·t) = B[0] + B[1]·Raiz[1]
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$$EcuaMat_1 := e^{\left(\frac{5}{2} + \frac{\sqrt{33}}{2}\right)t} = B_1 \left(\frac{5}{2} + \frac{\sqrt{33}}{2} \right) + B_0\quad (6)$$

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> EcuaMat[2] := exp(Raiz[2]·t) = B[0] + B[1]·Raiz[2]
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$$EcuaMat_2 := e^{\left(\frac{5}{2} - \frac{\sqrt{33}}{2}\right)t} = B_1 \left(\frac{5}{2} - \frac{\sqrt{33}}{2} \right) + B_0\quad (7)$$

```
> Para := solve({EcuaMat[1], EcuaMat[2]}, {B[0], B[1]}) : evalf(Para[1], 2);
evalf(Para[2], 2)
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$$\begin{aligned}B_0 &= 0.94 e^{-0.35 t} + 0.060 e^{5.5 t} \\ B_1 &= 0.17 e^{5.5 t} - 0.17 e^{-0.35 t}\end{aligned}\quad (8)$$

```
> MatExp := evalm(evalm(rhs(Para[1]) * II) + evalm(rhs(Para[2])·AA)) : evalf(MatExp[1,
1], 2); evalf(MatExp[1, 2], 2); evalf(MatExp[2, 1], 2); evalf(MatExp[2, 2], 2)
```

$$\begin{aligned}0.77 e^{-0.35 t} + 0.23 e^{5.5 t} \\ 0.35 e^{5.5 t} - 0.35 e^{-0.35 t} \\ 0.52 e^{5.5 t} - 0.52 e^{-0.35 t} \\ 0.26 e^{-0.35 t} + 0.74 e^{5.5 t}\end{aligned}\quad (9)$$

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

$$\begin{aligned} & 0.76 e^{-0.35 t} + 0.24 e^{5.5 t} \\ & 0.35 e^{5.5 t} - 0.35 e^{-0.35 t} \\ & 0.52 e^{5.5 t} - 0.52 e^{-0.35 t} \\ & 0.24 e^{-0.35 t} + 0.76 e^{5.5 t} \end{aligned} \quad (10)$$

> *IdentidadUno* := map(rcurry(eval, t=0'), MatExp)

$$IdentidadUno := \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad (11)$$

> *IdentidadDos* := map(rcurry(eval, t=0'), MatExpDos)

$$IdentidadDos := \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad (12)$$

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

$$\begin{aligned} \frac{d}{dt} x_1(t) &= x_1(t) + 2 x_2(t) \\ \frac{d}{dt} x_2(t) &= 3 x_1(t) + 4 x_2(t) \end{aligned} \quad (13)$$

> *CondIni* := x[0] = array([C[1], C[2]])

$$CondIni := x_0 = \begin{bmatrix} C_1 & C_2 \end{bmatrix} \quad (14)$$

> *SolGral* := evalm(MatExpDos &* rhs(CondIni)) : x[1](t) = evalf(SolGral[1], 2); x[2](t) = evalf(SolGral[2], 2);

$$\begin{aligned} x_1(t) &= (0.76 e^{-0.35 t} + 0.24 e^{5.5 t}) C_1 + (0.35 e^{5.5 t} - 0.35 e^{-0.35 t}) C_2 \\ x_2(t) &= (0.52 e^{5.5 t} - 0.52 e^{-0.35 t}) C_1 + (0.24 e^{-0.35 t} + 0.76 e^{5.5 t}) C_2 \end{aligned} \quad (15)$$

>

> *ComprobarUno* := simplify(subs(x[1](t) = SolGral[1], x[2](t) = SolGral[2], lhs(Sistema[1]) - rhs(Sistema[1]) = 0))

$$ComprobarUno := 0 = 0 \quad (16)$$

> *ComprobarDos* := simplify(subs(x[1](t) = SolGral[1], x[2](t) = SolGral[2], lhs(Sistema[2]) - rhs(Sistema[2]) = 0))

$$ComprobarDos := 0 = 0 \quad (17)$$

> *ComprobarTres* := x[1](0) = map(rcurry(eval, t=0'), SolGral[1])

$$ComprobarTres := x_1(0) = C_1 \quad (18)$$

> *ComprobarCuatro* := x[2](0) = map(rcurry(eval, t=0'), SolGral[2])

$$ComprobarCuatro := x_2(0) = C_2 \quad (19)$$

> restart

> *Sistema* := diff(x(t), t) = 4·x(t) - 5·y(t) + exp(2·t) + t, diff(y(t), t) = -6·x(t) + 7·y(t) + cos(2·t) : *Sistema*[1]; *Sistema*[2]

$$\frac{d}{dt} x(t) = 4 x(t) - 5 y(t) + e^{2 t} + t$$

$$\frac{d}{dt} y(t) = -6x(t) + 7y(t) + \cos(2t) \quad (20)$$

$$\begin{aligned} > \text{CondIni} := x(0) = 8, y(0) = -4 \\ & \text{CondIni} := x(0) = 8, y(0) = -4 \end{aligned} \quad (21)$$

$$\begin{aligned} > AA := \text{array}([[4, -5], [-6, 7]]) \\ & AA := \begin{bmatrix} 4 & -5 \\ -6 & 7 \end{bmatrix} \end{aligned} \quad (22)$$

$$\begin{aligned} > BB := \text{array}([\exp(2 \cdot t) + t, \cos(2 \cdot t)]) \\ & BB := \begin{bmatrix} e^{2t} + t & \cos(2t) \end{bmatrix} \end{aligned} \quad (23)$$

$$\begin{aligned} > Xcero := \text{array}([8, -4]) \\ & Xcero := \begin{bmatrix} 8 & -4 \end{bmatrix} \end{aligned} \quad (24)$$

$$\begin{aligned} > \text{with}(\text{linalg}) : \\ > \text{MatExp} := \text{exponential}(AA, t) : \text{evalf}(\text{MatExp}[1, 1], 3); \text{evalf}(\text{MatExp}[1, 2], 3); \\ & \text{evalf}(\text{MatExp}[2, 1], 3); \text{evalf}(\text{MatExp}[2, 2], 3) \\ & 0.632 e^{-0.200 t} + 0.368 e^{11.2 t} \\ & 0.442 e^{-0.200 t} - 0.442 e^{11.2 t} \\ & 0.530 e^{-0.200 t} - 0.530 e^{11.2 t} \\ & 0.368 e^{-0.200 t} + 0.632 e^{11.2 t} \end{aligned} \quad (25)$$

$$\begin{aligned} > \text{SolHom} := \text{evalm}(\text{MatExp} \& * Xcero) : \text{evalf}(\text{SolHom}[1], 3); \text{evalf}(\text{SolHom}[2], 3) \\ & 3.29 e^{-0.200 t} + 4.71 e^{11.2 t} \\ & 2.78 e^{-0.200 t} - 6.78 e^{11.2 t} \end{aligned} \quad (26)$$

$$\begin{aligned} > \text{CondInicial} := \text{map}(\text{rcurry}(\text{eval}, t=0'), \text{SolHom}) : x(0) = \text{CondInicial}[1]; y(0) \\ & = \text{CondInicial}[2]; \\ & x(0) = 8 \\ & y(0) = -4 \end{aligned} \quad (27)$$

$$\begin{aligned} > \text{CondIni} \\ & x(0) = 8, y(0) = -4 \end{aligned} \quad (28)$$

$$\begin{aligned} > \text{MatExpTau} := \text{map}(\text{rcurry}(\text{eval}, t=t - \text{tau}'), \text{MatExp}) : \\ > \text{BBtau} := \text{map}(\text{rcurry}(\text{eval}, t=\text{tau}'), BB) \\ & \text{BBtau} := \begin{bmatrix} e^{2\tau} + \tau & \cos(2\tau) \end{bmatrix} \end{aligned} \quad (29)$$

$$\begin{aligned} > \text{ProdTau} := \text{evalm}(\text{MatExpTau} \& * \text{BBtau}) : \\ > \text{SolNoHom} := \text{map}(\text{int}, \text{ProdTau}, \text{tau} = 0 .. t) : x(t) = \text{simplify}(\text{evalf}(\text{SolNoHom}[1], 3)); y(t) \\ & = \text{simplify}(\text{evalf}(\text{SolNoHom}[2], 3)) \\ & x(t) = -19.8 + 19.5 e^{-0.2 t} - 0.03 e^{11.2 t} + 0.250 e^{2 \cdot t} + 0.0577 \cos(2 \cdot t) + 0.212 \sin(2 \cdot t) \\ & + 3.50 t \end{aligned}$$

$$y(t) = -16.5 + 16.3 e^{-0.2 t} - 0.03 e^{11.2 t} + 0.300 e^{2 \cdot t} - 0.0385 \cos(2 \cdot t) + 0.192 \sin(2 \cdot t) + 3 \cdot t \quad (30)$$

$$\begin{aligned} > \text{ComprobarUno} := \text{map}(\text{rcurry}(\text{eval}, t=0'), \text{SolNoHom}[1]) \\ & \end{aligned} \quad (31)$$

$$\text{ComprobarUno} := 0 \quad (31)$$

$$\begin{aligned} &> \text{ComprobarDos} := \text{map}(\text{rcurry}(\text{eval}, t=0'), \text{SolNoHom}[2]) \\ &\quad \text{ComprobarDos} := 0 \end{aligned} \quad (32)$$

$$\begin{aligned} &> \text{SolPart} := \text{evalm}(\text{SolHom} + \text{SolNoHom}) : x(t) = \text{evalf}(\text{SolPart}[1], 3); y(t) \\ &\quad = \text{evalf}(\text{SolPart}[2], 3) \\ x(t) &= 3.29 e^{-0.200 t} + 4.65 e^{11.2 t} - 19.8 + 19.5 e^{-0.20 t} + 0.250 e^{2. t} + 0.0577 \cos(2. t) \\ &\quad + 0.212 \sin(2. t) + 3.50 t \\ y(t) &= 2.78 e^{-0.200 t} - 6.81 e^{11.2 t} - 16.5 + 16.3 e^{-0.20 t} + 0.300 e^{2. t} - 0.0385 \cos(2. t) \\ &\quad + 0.192 \sin(2. t) + 3. t \end{aligned} \quad (33)$$

$$\begin{aligned} &> \text{Sistema}[1]; \text{Sistema}[2] \\ &\quad \frac{d}{dt} x(t) = 4 x(t) - 5 y(t) + e^{2 t} + t \\ &\quad \frac{d}{dt} y(t) = -6 x(t) + 7 y(t) + \cos(2 t) \end{aligned} \quad (34)$$

$$\begin{aligned} &> \text{ComprobacionTres} := \text{simplify}(\text{eval}(\text{subs}(x(t) = \text{SolPart}[1], y(t) = \text{SolPart}[2], \text{lhs}(\text{Sistema}[1]) \\ &\quad - \text{rhs}(\text{Sistema}[1]) = 0))) \\ &\quad \text{ComprobacionTres} := 0 = 0 \end{aligned} \quad (35)$$

$$\begin{aligned} &> \text{ComprobacionCuatro} := \text{simplify}(\text{eval}(\text{subs}(x(t) = \text{SolPart}[1], y(t) = \text{SolPart}[2], \\ &\quad \text{lhs}(\text{Sistema}[2]) - \text{rhs}(\text{Sistema}[2]) = 0))) \\ &\quad \text{ComprobacionCuatro} := 0 = 0 \end{aligned} \quad (36)$$

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