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> restart
> Sistema := diff(y1(t), t) = y2(t) + y3(t), diff(y2(t), t) = y1(t) + y3(t), diff(y3(t), t) = y1(t)
+ y2(t) : Sistema1; Sistema2; Sistema3
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$$\frac{d}{dt} y_1(t) = y_2(t) + y_3(t)$$

$$\frac{d}{dt} y_2(t) = y_1(t) + y_3(t)$$

$$\frac{d}{dt} y_3(t) = y_1(t) + y_2(t)$$

(1)

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> AA := array([ [0, 1, 1], [1, 0, 1], [1, 1, 0] ])
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$$AA := \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

(2)

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> with(linalg) :
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> MatExp := exponential(AA, t)
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$$MatExp := \begin{bmatrix} \frac{2}{3} e^{-t} + \frac{1}{3} e^{2t} & \frac{1}{3} e^{2t} - \frac{1}{3} e^{-t} & \frac{1}{3} e^{2t} - \frac{1}{3} e^{-t} \\ \frac{1}{3} e^{2t} - \frac{1}{3} e^{-t} & \frac{2}{3} e^{-t} + \frac{1}{3} e^{2t} & \frac{1}{3} e^{2t} - \frac{1}{3} e^{-t} \\ \frac{1}{3} e^{2t} - \frac{1}{3} e^{-t} & \frac{1}{3} e^{2t} - \frac{1}{3} e^{-t} & \frac{2}{3} e^{-t} + \frac{1}{3} e^{2t} \end{bmatrix}$$

(3)

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> MatExp[1, 1]; MatExp[1, 2]; MatExp[1, 3]; MatExp[2, 1]; MatExp[2, 2]; MatExp[2, 3];
MatExp[3, 1]; MatExp[3, 2]; MatExp[3, 3];
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$$\frac{2}{3} e^{-t} + \frac{1}{3} e^{2t}$$

$$\frac{1}{3} e^{2t} - \frac{1}{3} e^{-t}$$

$$\frac{1}{3} e^{2t} - \frac{1}{3} e^{-t}$$

$$\frac{1}{3} e^{2t} - \frac{1}{3} e^{-t}$$

$$\frac{2}{3} e^{-t} + \frac{1}{3} e^{2t}$$

$$\frac{1}{3} e^{2t} - \frac{1}{3} e^{-t}$$

$$\frac{1}{3} e^{2t} - \frac{1}{3} e^{-t}$$

$$\frac{1}{3} e^{2t} - \frac{1}{3} e^{-t}$$

$$\frac{2}{3} e^{-t} + \frac{1}{3} e^{2t}$$

(4)

> *DerMatExp* := *map*(*diff*, *MatExp*, *t*)

$$DerMatExp := \begin{bmatrix} -\frac{2}{3} e^{-t} + \frac{2}{3} e^{2t} & \frac{2}{3} e^{2t} + \frac{1}{3} e^{-t} & \frac{2}{3} e^{2t} + \frac{1}{3} e^{-t} \\ \frac{2}{3} e^{2t} + \frac{1}{3} e^{-t} & -\frac{2}{3} e^{-t} + \frac{2}{3} e^{2t} & \frac{2}{3} e^{2t} + \frac{1}{3} e^{-t} \\ \frac{2}{3} e^{2t} + \frac{1}{3} e^{-t} & \frac{2}{3} e^{2t} + \frac{1}{3} e^{-t} & -\frac{2}{3} e^{-t} + \frac{2}{3} e^{2t} \end{bmatrix} \quad (5)$$

> *Comp*<sub>1</sub> := *evalm*(*DerMatExp* - *evalm*(*AA* &\* *MatExp*));

$$Comp_1 := \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad (6)$$

> *InvMatExp* := *exponential*(*AA*, -*t*)

$$InvMatExp := \begin{bmatrix} \frac{2}{3} e^t + \frac{1}{3} e^{-2t} & \frac{1}{3} e^{-2t} - \frac{1}{3} e^t & \frac{1}{3} e^{-2t} - \frac{1}{3} e^t \\ \frac{1}{3} e^{-2t} - \frac{1}{3} e^t & \frac{2}{3} e^t + \frac{1}{3} e^{-2t} & \frac{1}{3} e^{-2t} - \frac{1}{3} e^t \\ \frac{1}{3} e^{-2t} - \frac{1}{3} e^t & \frac{1}{3} e^{-2t} - \frac{1}{3} e^t & \frac{2}{3} e^t + \frac{1}{3} e^{-2t} \end{bmatrix} \quad (7)$$

> *Comp*<sub>2</sub> := *simplify*(*evalm*(*MatExp* &\* *InvMatExp*));

$$Comp_2 := \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad (8)$$

> *Comp*<sub>3</sub> := *map*(*rcurry*(*eval*, *t*='0'), *MatExp*);

$$Comp_3 := \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad (9)$$

> *MatrizOriginal* := *map*(*rcurry*(*eval*, *t*='0'), *DerMatExp*);

$$MatrizOriginal := \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} \quad (10)$$

> *Ycero* := *array*([ -3, 2, -1 ])

$$Ycero := \begin{bmatrix} -3 & 2 & -1 \end{bmatrix} \quad (11)$$

> *Sol* := *evalm*(*MatExp* &\* *Ycero*) : *yy*<sub>1</sub>(*t*) = *Sol*<sub>1</sub>; *yy*<sub>2</sub>(*t*) = *Sol*<sub>2</sub>; *yy*<sub>3</sub>(*t*) = *Sol*<sub>3</sub>;

$$yy_1(t) = -\frac{7}{3} e^{-t} - \frac{2}{3} e^{2t}$$

$$\begin{aligned} yy_2(t) &= -\frac{2}{3} e^{2t} + \frac{8}{3} e^{-t} \\ yy_3(t) &= -\frac{2}{3} e^{2t} - \frac{1}{3} e^{-t} \end{aligned} \quad (12)$$

$$\begin{aligned} &> \text{Condiciones} := y_1(0) = -3, y_2(0) = 2, y_3(0) = -1; \\ &\quad \text{Condiciones} := y_1(0) = -3, y_2(0) = 2, y_3(0) = -1 \end{aligned} \quad (13)$$

$$\begin{aligned} &> \text{Sistema}_1; \text{Sistema}_2; \text{Sistema}_3; \\ &\quad \frac{d}{dt} y_1(t) = y_2(t) + y_3(t) \\ &\quad \frac{d}{dt} y_2(t) = y_1(t) + y_3(t) \\ &\quad \frac{d}{dt} y_3(t) = y_1(t) + y_2(t) \end{aligned} \quad (14)$$

$$\begin{aligned} &> \text{SolPart} := \text{dsolve}(\{\text{Sistema}, \text{Condiciones}\}) : \text{SolPart}_1; \text{SolPart}_2; \text{SolPart}_3; \\ &\quad y_1(t) = -\frac{7}{3} e^{-t} - \frac{2}{3} e^{2t} \\ &\quad y_2(t) = -\frac{2}{3} e^{2t} + \frac{8}{3} e^{-t} \\ &\quad y_3(t) = -\frac{2}{3} e^{2t} - \frac{1}{3} e^{-t} \end{aligned} \quad (15)$$

$$\begin{aligned} &> \text{Comp}_4 := \text{simplify}(\text{eval}(\text{subs}(y_1(t) = \text{rhs}(\text{SolPart}_1), y_2(t) = \text{rhs}(\text{SolPart}_2), y_3(t) \\ &\quad = \text{rhs}(\text{SolPart}_3), \text{lhs}(\text{Sistema}_1) - \text{rhs}(\text{Sistema}_1) = 0))) \\ &\quad \text{Comp}_4 := 0 = 0 \end{aligned} \quad (16)$$

$$\begin{aligned} &> \text{Comp}_5 := \text{simplify}(\text{eval}(\text{subs}(y_1(t) = \text{rhs}(\text{SolPart}_1), y_2(t) = \text{rhs}(\text{SolPart}_2), y_3(t) \\ &\quad = \text{rhs}(\text{SolPart}_3), \text{lhs}(\text{Sistema}_2) - \text{rhs}(\text{Sistema}_2) = 0))) \\ &\quad \text{Comp}_5 := 0 = 0 \end{aligned} \quad (17)$$

$$\begin{aligned} &> \text{Comp}_6 := \text{simplify}(\text{eval}(\text{subs}(y_1(t) = \text{rhs}(\text{SolPart}_1), y_2(t) = \text{rhs}(\text{SolPart}_2), y_3(t) \\ &\quad = \text{rhs}(\text{SolPart}_3), \text{lhs}(\text{Sistema}_3) - \text{rhs}(\text{Sistema}_3) = 0))) \\ &\quad \text{Comp}_6 := 0 = 0 \end{aligned} \quad (18)$$

$$\begin{aligned} &> \text{Comp}_7 := \text{eval}(\text{subs}(t = 0, \text{SolPart}_1)); \\ &\quad \text{Comp}_7 := y_1(0) = -3 \end{aligned} \quad (19)$$

$$\begin{aligned} &> \text{Comp}_8 := \text{eval}(\text{subs}(t = 0, \text{SolPart}_2)); \\ &\quad \text{Comp}_8 := y_2(0) = 2 \end{aligned} \quad (20)$$

$$\begin{aligned} &> \text{Comp}_9 := \text{eval}(\text{subs}(t = 0, \text{SolPart}_3)); \\ &\quad \text{Comp}_9 := y_3(0) = -1 \end{aligned} \quad (21)$$

$$\begin{aligned} &> \text{restart} \\ &> \text{AA} := \text{array}([ [0, 1, 0], [0, 0, 1], [6, -4, 3] ]) \end{aligned} \quad (22)$$

$$AA := \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 6 & -4 & 3 \end{bmatrix} \quad (22)$$

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> with(linalg) :
> MatExp := exponential(AA, t) : evalf(simplify(MatExp[1, 1]), 4)
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$$0.3763 e^{2.379 t} - 0.6989 e^{0.3107 t} \sin(1.558 t) + 0.6239 e^{0.3107 t} \cos(1.558 t) \quad (23)$$

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> EcuCarac := expand( (m - 2.379) · (m - 0.3107 + 1.558 I) · (m - 0.3107 - 1.558 I) ) = 0
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$$EcuCarac := m^3 - 3.0004 m^2 - 6.004354508 + 0. I + 4.00220909 m = 0 \quad (24)$$

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