NOMBRE DEL ALUMNO <=======

SERIE 3 (CAPÍTULO III)
SEMESTRE 2024-1

Octubre 29 de 2023

> *restart*

1) OBTENER LA TRANSFORMADA INVERSA DE LAPLACE

a) UTILIZANDO EL TEOREMA DE LA CONVOLUCIÓN DE LA SIGUIENTE FUNCIÓN

> $F := \frac{1}{s\cdot(s\cdot\cdot 2+1)}$

$$F := \frac{1}{s\,(s^2+1)} \quad \textbf{(1)}$$

>

RESPUESTA

> $G := \frac{1}{s}; H := \frac{1}{s^2+1}$

$$G := \frac{1}{s}$$

$$H := \frac{1}{s^2+1} \quad \textbf{(2)}$$

> $with(inttrans):$

> $g := invlaplace(G, s, t)$

$$g := 1 \quad \textbf{(3)}$$

> $h := invlaplace(H, s, t)$

$$h := \sin(t) \quad \textbf{(4)}$$

> $f := int(\sin(\mathrm{tau})\cdot 1, \mathrm{tau}=0..t)$

$$f := 1-\cos(t) \quad \textbf{(5)}$$

> $ff := invlaplace(F, s, t)$

$$ff := 1-\cos(t) \quad \textbf{(6)}$$

> *restart*

b) UTILIZANDO DIVERSAS PROPIEDADES

> $G := \frac{(\exp(-4\cdot s)+s-3)}{s\cdot\cdot 2-6\cdot s-7}$

$$G := \frac{e^{-4\,s}+s-3}{s^2-6\,s-7} \quad \textbf{(7)}$$

RESPUESTA

> $H := \frac{\exp(-4\cdot s)}{s^2-6\cdot s-7}$

$$H := \frac{e^{-4s}}{s^2 - 6s - 7} \quad (8)$$

> $J := \frac{s-3}{s^2 - 6 \cdot s - 7}$

$$J := \frac{s-3}{s^2 - 6s - 7} \quad (9)$$

> $with(inttrans):$

> $h := invlaplace(H, s, t)$

$$h := \frac{\mathrm{Heaviside}(t-4)\, e^{3t-12} \sinh(4t-16)}{4} \quad (10)$$

> $j := invlaplace(J, s, t)$

$$j := e^{3t} \cosh(4t) \quad (11)$$

> $g := h + j$

$$g := \frac{\mathrm{Heaviside}(t-4)\, e^{3t-12} \sinh(4t-16)}{4} + e^{3t} \cosh(4t) \quad (12)$$

>

> $restart$

2) OBTENER LA SOLUCIÓN DEL SIGUIENTE PROBLEMA DE CONDICIONES INICIALES UTILIZANDO LA TRANSFORMADA DE LAPLACE

> $diff(y(t), t\$2) - 5 \cdot diff(y(t), t) + 4 \cdot y(t) = 4 \cdot \exp(4 \cdot t); y(0) = 0; \mathrm{D}(y)(0) = 2$

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

$$y(0) = 0$$

$$\mathrm{D}(y)(0) = 2 \quad (13)$$

RESPUESTA

> $ECUA := diff(y(t), t\$2) - 5 \cdot diff(y(t), t) + 4 \cdot y(t) = 4 \cdot \exp(4 \cdot t)$

$$ECUA := \frac{d^2}{dt^2} y(t) - 5 \frac{d}{dt} y(t) + 4\, y(t) = 4\, e^{4t} \quad (14)$$

> $CondIni := y(0) = 0, \mathrm{D}(y)(0) = 2$

$$CondIni := y(0) = 0, \mathrm{D}(y)(0) = 2 \quad (15)$$

> $with(inttrans):$

> $EcuaTL := subs(CondIni, laplace(lhs(ECUA), t, s) = laplace(rhs(ECUA), t, s))$

$$EcuaTL := s^2 \mathcal{L}(y(t), t, s) - 2 - 5\, s\, \mathcal{L}(y(t), t, s) + 4\, \mathcal{L}(y(t), t, s) = \frac{4}{s-4} \quad (16)$$

> $SolPartTL := simplify(isolate(EcuaTL, laplace(y(t), t, s)))$

(17)

$$SolPartTL := \mathcal{L}(y(t), t, s) = \frac{-4 + 2s}{(s-4)^2 (s-1)} \quad \textbf{(17)}$$

> $SolPart := invlaplace(SolPartTL, s, t)$

$$SolPart := y(t) = -\frac{2e^t}{9} + \frac{2e^{4t}(6t+1)}{9} \quad \textbf{(18)}$$

>

> *restart*

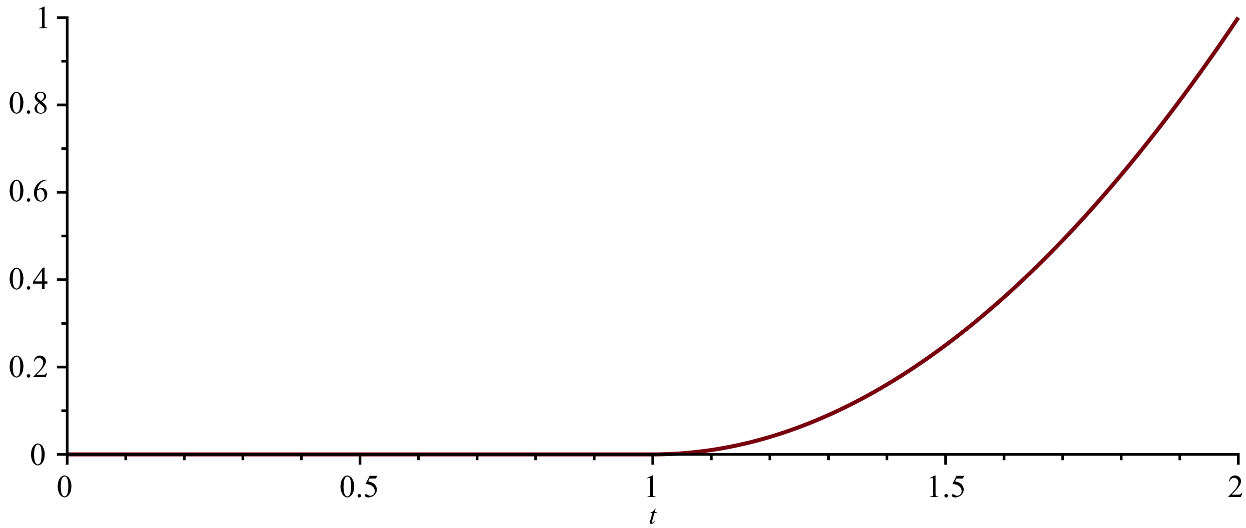
3) DADA LA FUNCIÓN

> $f := (t-1)\cdot\cdot 2\cdot \text{Heaviside}(t-1)$

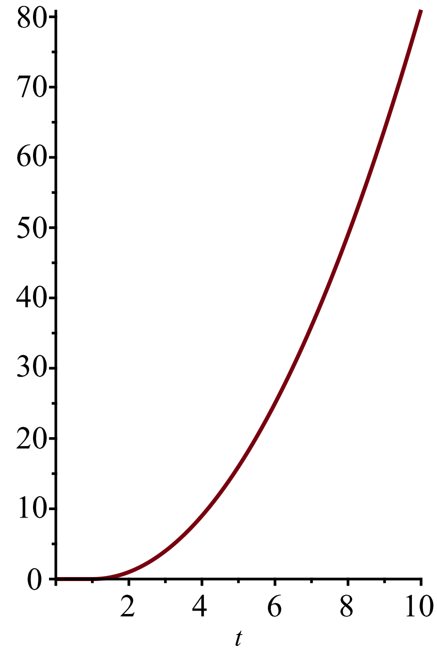
$$f := (t-1)^2\ \text{Heaviside}(t-1) \quad \textbf{(19)}$$

a) GRAFIQUE LA FUNCIÓN PARA 0 < t < 10

> $plot(f, t=0..2)$



> $plot(f, t=0..10)$



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b) OBTENER LA TRANSFORMADA DE LA FUNCIÓN

> *with*(*inttrans*) :

> $F := laplace(f, t, s)$

$$F := \frac{2\, e^{-s}}{s^3} \tag{20}$$

>

> *restart*

4)

a) OBTENER LA MATRIZ A CUYA MATRIZ EXPONENCIAL ESTÁ DADA

> $MatExp := \frac{1}{2}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} e^{-t} + \frac{1}{2}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} e^{3t}$

$$MatExp := \begin{bmatrix} \frac{e^{-t}}{2} + \frac{e^{3t}}{2} & -\frac{e^{-t}}{2} + \frac{e^{3t}}{2} \\ -\frac{e^{-t}}{2} + \frac{e^{3t}}{2} & \frac{e^{-t}}{2} + \frac{e^{3t}}{2} \end{bmatrix} \tag{21}$$

RESPUESTA

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

$$DerMatExp := \begin{bmatrix} -\frac{e^{-t}}{2} + \frac{3\, e^{3t}}{2} & \frac{e^{-t}}{2} + \frac{3\, e^{3t}}{2} \\ \frac{e^{-t}}{2} + \frac{3\, e^{3t}}{2} & -\frac{e^{-t}}{2} + \frac{3\, e^{3t}}{2} \end{bmatrix} \tag{22}$$

> $InvMatExp := map(rcurry(eval, t='-t'), MatExp)$

$$InvMatExp := \begin{bmatrix} \frac{e^{t}}{2} + \frac{e^{-3\,t}}{2} & -\frac{e^{t}}{2} + \frac{e^{-3\,t}}{2} \\ -\frac{e^{t}}{2} + \frac{e^{-3\,t}}{2} & \frac{e^{t}}{2} + \frac{e^{-3\,t}}{2} \end{bmatrix} \quad \textbf{(23)}$$

> $AA := simplify(evalm(\ DerMatExp\ \&*\ InvMatExp))$

$$AA := \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix} \quad \textbf{(24)}$$

>

b) CON LA MATRIZ **A** OBTENIDA EN EL INCISO [a)] PROPONER UN SISTEMA HOMOGÉNEO DE ECUACIONES DIFERENCIALES CON **x(t) & y(t)** COMO INCÓGNITAS

> $Sistema := diff(x(t), t) = x(t) + 2\cdot y(t), diff(y(t), t) = 2\cdot x(t) + y(t) : Sistema[1]; Sistema[2]$

$$\frac{d}{dt}\, x(t) = x(t) + 2\, y(t)$$

$$\frac{d}{dt}\, y(t) = 2\, x(t) + y(t) \quad \textbf{(25)}$$

>

c) OBTENER LA SOLUCIÓN GENERAL DEL SISTEMA OBTENIDO EN EL INCISO [b)] MEDIANTE **dsolve**

> $SolGral := dsolve(\{Sistema\}) : SolGral[1]; SolGral[2]$

$$x(t) = c_1\, e^{3\,t} + c_2\, e^{-t}$$

$$y(t) = c_1\, e^{3\,t} - c_2\, e^{-t} \quad \textbf{(26)}$$

>

> **restart:**

5) DADA LA ECUACIÓN DIFERENCIAL DE CUARTO ORDEN SIGUIENTE:

>

a) OBTENER UN SISTEMA DE ECUACIONES DIFERENCIALES EQUIVALENTE (CON TODO Y CONDICIONES INICIALES)

> $Sistema := diff(y[1](t), t) = y[2](t), diff(y[2](t), t) = y[3](t), diff(y[3](t), t) = y[4](t),$
$diff(y[4](t), t) = 4\cdot y[1](t) - 5\cdot y[3](t) + 5\, e^{-2\,t}\sin(3\,t) : Sistema[1]; Sistema[2];$
$Sistema[3]; Sistema[4];$

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

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

$$\frac{d}{dt} y_3(t) = y_4(t)$$

$$\frac{d}{dt} y_4(t) = 4\,y_1(t) - 5\,y_3(t) + 5\,e^{-2\,t} \sin(3\,t) \quad \textbf{(27)}$$

> *CondIni* := y[1](0) = −5, y[2](t) = −3, y[3](t) = 4, y[4](t) = 2 : *CondIni*[1]; *CondIni*[2]; *CondIni*[3]; *CondIni*[4];

$$y_1(0) = -5$$

$$y_2(t) = -3$$

$$y_3(t) = 4$$

$$y_4(t) = 2 \quad \textbf{(28)}$$

>

b) MOSTRAR LA REPRESENTACIÓN MATRICIAL DEL MISMO SISTEMA

> *Y* := *array*([y[1](t), y[2](t), y[3](t), y[4](t)])

$$Y := \begin{bmatrix} y_1(t) & y_2(t) & y_3(t) & y_4(t) \end{bmatrix} \quad \textbf{(29)}$$

> *DerY* := *map*(*diff*, *Y*, *t*)

$$DerY := \begin{bmatrix} \frac{d}{dt} y_1(t) & \frac{d}{dt} y_2(t) & \frac{d}{dt} y_3(t) & \frac{d}{dt} y_4(t) \end{bmatrix} \quad \textbf{(30)}$$

> *AA* := *array*([[0, 1, 0, 0], [0, 0, 1, 0], [0, 0, 0, 1], [4, 0, −5, 0]])

$$AA := \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 4 & 0 & -5 & 0 \end{bmatrix} \quad \textbf{(31)}$$

> *BB* := *array*([0, 0, 0, 5 e^{−2 t} sin(3 t)])

$$BB := \begin{bmatrix} 0 & 0 & 0 & 5\,e^{-2\,t} \sin(3\,t) \end{bmatrix} \quad \textbf{(32)}$$

> *Xcero* := *array*([−5, −3, 4, 2])

$$Xcero := \begin{bmatrix} -5 & -3 & 4 & 2 \end{bmatrix} \quad \textbf{(33)}$$

c) OBTENER LA MATRIZ EXPONENCIAL QUE NOS PERMITA RESOLVERLO

> *with*(*linalg*) :

> *MatExp* := *exponential*(*AA*, *t*) : *evalf*(*MatExp*[1, 1], 2); *evalf*(*MatExp*[2, 1], 2); *evalf*(*MatExp*[3, 1], 2); *evalf*(*MatExp*[4, 1], 2)

$$0.43\,e^{0.85\,t} + 0.43\,e^{-0.85\,t} + 0.11\cos(2.4\,t)$$

$$-0.26\sin(2.4\,t) + 0.37\,e^{0.85\,t} - 0.37\,e^{-0.85\,t}$$

$$-0.63\cos(2.4\,t) + 0.31\,e^{0.85\,t} + 0.31\,e^{-0.85\,t}$$

(34)

$$1.5\sin(2.4\,t)+0.30\,e^{0.85\,t}-0.30\,e^{-0.85\,t} \quad \textbf{(34)}$$

> *evalf*(*MatExp*[1, 2], 2); *evalf*(*MatExp*[2, 2], 2); *evalf*(*MatExp*[3, 2], 2); *evalf*(*MatExp*[4, 2], 2)

$$0.047\sin(2.4\,t)+0.53\,e^{0.85\,t}-0.53\,e^{-0.85\,t}$$

$$0.43\,e^{0.85\,t}+0.43\,e^{-0.85\,t}+0.11\cos(2.4\,t)$$

$$-0.26\sin(2.4\,t)+0.37\,e^{0.85\,t}-0.37\,e^{-0.85\,t}$$

$$-0.63\cos(2.4\,t)+0.31\,e^{0.85\,t}+0.31\,e^{-0.85\,t} \quad \textbf{(35)}$$

> *evalf*(*MatExp*[1, 3], 2); *evalf*(*MatExp*[2, 3], 2); *evalf*(*MatExp*[3, 3], 2); *evalf*(*MatExp*[4, 3], 2)

$$-0.16\cos(2.4\,t)+0.078\,e^{0.85\,t}+0.078\,e^{-0.85\,t}$$

$$0.37\sin(2.4\,t)+0.065\,e^{0.85\,t}-0.065\,e^{-0.85\,t}$$

$$0.054\,e^{0.85\,t}+0.054\,e^{-0.85\,t}+0.90\cos(2.4\,t)$$

$$-2.1\sin(2.4\,t)+0.048\,e^{0.85\,t}-0.048\,e^{-0.85\,t} \quad \textbf{(36)}$$

> *evalf*(*MatExp*[1, 4], 2); *evalf*(*MatExp*[2, 4], 2); *evalf*(*MatExp*[3, 4], 2); *evalf*(*MatExp*[4, 4], 2)

$$-0.065\sin(2.4\,t)+0.094\,e^{0.85\,t}-0.094\,e^{-0.85\,t}$$

$$-0.16\cos(2.4\,t)+0.078\,e^{0.85\,t}+0.078\,e^{-0.85\,t}$$

$$0.37\sin(2.4\,t)+0.065\,e^{0.85\,t}-0.065\,e^{-0.85\,t}$$

$$0.054\,e^{0.85\,t}+0.054\,e^{-0.85\,t}+0.90\cos(2.4\,t) \quad \textbf{(37)}$$

>

d) OBTENER LA SOLUCIÓN PARTICULAR DADAS LAS CONDICIONES SEÑALADAS UTILIZANDO EL MÉTODO DE MATRIZ EXPONENCIAL

> *SolHom* := *evalm*(*MatExp* &* *Xcero*) : *Y*[1] = *evalf*(*SolHom*[1], 2); *Y*[2] = *evalf*(*SolHom*[2], 2); *Y*[3] = *evalf*(*SolHom*[3], 2); *Y*[4] = *evalf*(*SolHom*[4], 2);

$$y_1(t)=-3.2\,e^{0.85\,t}-0.4\,e^{-0.85\,t}-1.2\cos(2.4\,t)-0.27\sin(2.4\,t)$$

$$y_2(t)=2.8\sin(2.4\,t)-2.8\,e^{0.85\,t}+0.25\,e^{-0.85\,t}-0.68\cos(2.4\,t)$$

$$y_3(t)=6.8\cos(2.4\,t)-2.3\,e^{0.85\,t}-0.4\,e^{-0.85\,t}+1.5\sin(2.4\,t)$$

$$y_4(t)=-16.\sin(2.4\,t)-2.1\,e^{0.85\,t}+0.46\,e^{-0.85\,t}+3.7\cos(2.4\,t) \quad \textbf{(38)}$$

> *Comprobar* := *simplify*(*map*(*rcurry*(*eval*, *t* ='0'), *SolHom*))

$$Comprobar := \begin{bmatrix} -5 & -3 & 4 & 2 \end{bmatrix} \quad \textbf{(39)}$$

> *MatExpTau* := *map*(*rcurry*(*eval*, *t* ='*t* − tau'), *MatExp*) :

> *BBtau* := *map*(*rcurry*(*eval*, *t* ='tau'), *BB*)

$$BBtau := \begin{bmatrix} 0 & 0 & 0 & 5\,e^{-2\,\tau}\sin(3\,\tau) \end{bmatrix} \quad \textbf{(40)}$$

> $ProdTau := evalm(MatExpTau \&* BBtau):$

> $SolNoHom := map(int, ProdTau, tau = 0..t) : Y[1] = evalf(SolNoHom[1], 2); Y[2] = evalf(SolNoHom[2], 2); Y[3] = evalf(SolNoHom[3], 2); Y[4] = evalf(SolNoHom[4], 2);$

$$y_1(t) = 0.082\, e^{0.85\, t} - 0.13\, e^{-0.85\, t} + 0.062\cos(2.4\, t) - 0.029\sin(3.\, t)\, e^{-2.\, t} - 0.012\cos(3.\, t)\, e^{-2.\, t} - 0.053\sin(2.4\, t)$$

$$y_2(t) = -0.15\sin(2.4\, t) + 0.071\, e^{0.85\, t} + 0.12\, e^{-0.85\, t} - 0.12\cos(2.4\, t) + 0.093\sin(3.\, t)\, e^{-2.\, t} - 0.064\cos(3.\, t)\, e^{-2.\, t}$$

$$y_3(t) = -0.37\cos(2.4\, t) + 0.053\, e^{0.85\, t} - 0.086\, e^{-0.85\, t} + 0.40\cos(3.\, t)\, e^{-2.\, t} + 0.0038\sin(3.\, t)\, e^{-2.\, t} + 0.28\sin(2.4\, t)$$

$$y_4(t) = 0.88\sin(2.4\, t) + 0.05\, e^{0.85\, t} + 0.09\, e^{-0.85\, t} + 0.68\cos(2.4\, t) - 0.80\cos(3.\, t)\, e^{-2.\, t} - 1.2\sin(3.\, t)\, e^{-2.\, t} \quad \textbf{(41)}$$

> $ComprobarDos := simplify(map(rcurry(eval, t='0'), SolNoHom))$

$$ComprobarDos := \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(42)}$$

> $SolPart := Y[1] = simplify(evalf(SolHom[1], 2) + evalf(SolNoHom[1], 2)), Y[2] = simplify(evalf(SolHom[2], 2) + evalf(SolNoHom[2], 2)), Y[3] = simplify(evalf(SolHom[3], 2) + evalf(SolNoHom[3], 2)), Y[4] = simplify(evalf(SolHom[4], 2) + evalf(SolNoHom[4], 2)) : SolPart[1]; SolPart[2]; SolPart[3]; SolPart[4];$

$$y_1(t) = (-0.029\sin(3.\, t) - 0.012\cos(3.\, t))\, e^{-2.\, t} - 3.118\, e^{0.85\, t} - 0.53\, e^{-0.85\, t} - 1.138\cos(2.4\, t) - 0.323\sin(2.4\, t)$$

$$y_2(t) = (0.093\sin(3.\, t) - 0.064\cos(3.\, t))\, e^{-2.\, t} + 2.65\sin(2.4\, t) - 2.729\, e^{0.85\, t} + 0.37\, e^{-0.85\, t} - 0.80\cos(2.4\, t)$$

$$y_3(t) = (0.40\cos(3.\, t) + 0.0038\sin(3.\, t))\, e^{-2.\, t} + 6.43\cos(2.4\, t) - 2.247\, e^{0.85\, t} - 0.486\, e^{-0.85\, t} + 1.78\sin(2.4\, t)$$

$$y_4(t) = (-0.80\cos(3.\, t) - 1.2\sin(3.\, t))\, e^{-2.\, t} - 15.12\sin(2.4\, t) - 2.05\, e^{0.85\, t} + 0.55\, e^{-0.85\, t} + 4.38\cos(2.4\, t) \quad \textbf{(43)}$$

>

> **restart:**

6) DADO EL SISTEMA, Y CON LAS CONDICIONES: **x(0) = 3; y(0) = -4; z(0) = 6**

>

RESPUESTA

> $Sistema := \frac{d}{dt}x(t) = x(t) - y(t) + z(t), \frac{d}{dt}y(t) = -x(t) + y(t) + z(t) + 2\, e^{t}, \frac{d}{dt}z(t) = x(t)$

$+ y(t) - z(t) + e^{3t}$: Sistema[1]; Sistema[2]; Sistema[3];

$$\frac{d}{dt} x(t) = x(t) - y(t) + z(t)$$

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

$$\frac{d}{dt} z(t) = x(t) + y(t) - z(t) + e^{3t} \quad \textbf{(44)}$$

> $CondIni := x(0) = 3, y(0) = -4, z(0) = 6$

$$CondIni := x(0) = 3, y(0) = -4, z(0) = 6 \quad \textbf{(45)}$$

>

a) OBTENER LA SOLUCIÓN PARTICULAR UTILIZANDO **dsolve**

> $SolPart := dsolve(\{Sistema, CondIni\})$: $SolPart[1]; SolPart[2]; SolPart[3];$

$$x(t) = \frac{2\, t\, e^{t}}{3} + \frac{e^{3t}}{10} + \frac{47\, e^{t}}{18} - \frac{199\, e^{-2t}}{90} + \frac{5\, e^{2t}}{2}$$

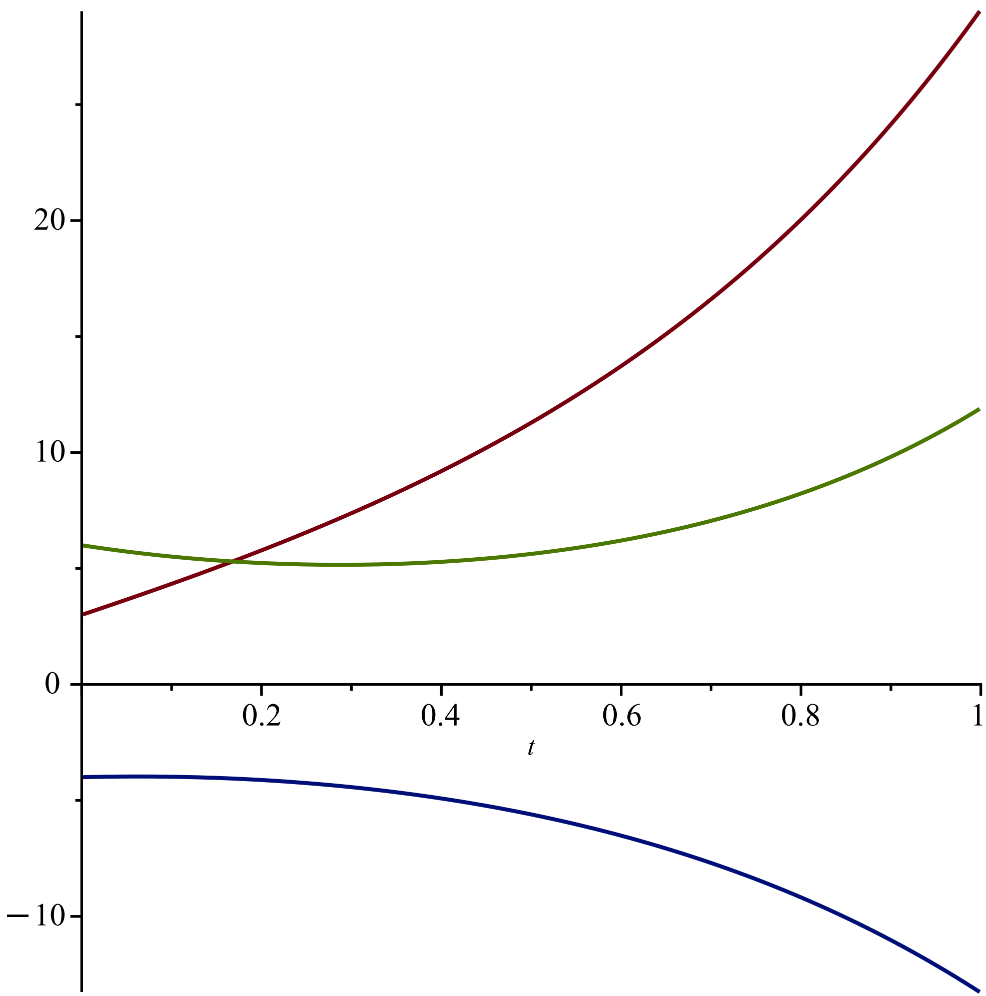
$$y(t) = \frac{e^{3t}}{10} + \frac{2\, t\, e^{t}}{3} + \frac{11\, e^{t}}{18} - \frac{5\, e^{2t}}{2} - \frac{199\, e^{-2t}}{90}$$

$$z(t) = \frac{3\, e^{3t}}{10} + \frac{2\, t\, e^{t}}{3} + \frac{23\, e^{t}}{18} + \frac{199\, e^{-2t}}{45} \quad \textbf{(46)}$$

>

b) GRAFICAR LA SOLUCIÓN DEL SISTEMA OBTENIDA EN EL INCISO [a)] (FUNCIONES JUNTAS EN UN SOLO GRÁFICO) CON UN INTERVALO **0 < t < 1**

> $plot([rhs(SolPart[1]), rhs(SolPart[2]), rhs(SolPart[3])], t = 0 ..1)$



>

c) ESTABLECER LA MATRIZ A DEL MISMO SISTEMA Y RESOLVERLO, TAMBIÉN, CON LA MATRIZ EXPONENCIAL

> $AA := array([[1,-1,1],[-1,1,1],[1,1,-1]])$

$$AA := \begin{bmatrix} 1 & -1 & 1 \\ -1 & 1 & 1 \\ 1 & 1 & -1 \end{bmatrix} \quad \mathbf{(47)}$$

> $Xcero := array([3,-4,6])$

$$Xcero := \begin{bmatrix} 3 & -4 & 6 \end{bmatrix} \quad \mathbf{(48)}$$

> $BB := array([0, 2\cdot\exp(t), \exp(3\cdot t)])$

$$BB := \begin{bmatrix} 0 & 2\,e^{t} & e^{3\,t} \end{bmatrix} \quad \mathbf{(49)}$$

> $with(linalg):$

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

$$\frac{e^{t}}{3} + \frac{e^{2\,t}}{2} + \frac{e^{-2\,t}}{6} \quad \mathbf{(50)}$$

> $SolHom := evalm(MatExp \&* Xcero) : SolHom[1]; x(0) = simplify(subs(t=0, SolHom[1])); y(0) = simplify(subs(t=0, SolHom[2])); z(0) = simplify(subs(t=0, SolHom[3]))$

$$\frac{5\,e^{t}}{3}+\frac{7\,e^{2t}}{2}-\frac{13\,e^{-2t}}{6}$$

$$x(0)=3$$

$$y(0)=-4$$

$$z(0)=6 \qquad (51)$$

> $MatExpTau := map(rcurry(eval, t='t-\tau'), MatExp) :$

> $BBtau := map(rcurry(eval, t='\tau'), BB)$

$$BBtau := \begin{bmatrix} 0 & 2\,e^{\tau} & e^{3\tau} \end{bmatrix} \qquad (52)$$

> $ProdTau := evalm(MatExpTau \&* BBtau) :$

> $SolNoHom := map(int, ProdTau, \tau=0..t) :$

> $SolPart := x(t) = SolHom[1] + SolNoHom[1]; y(t) = SolHom[2] + SolNoHom[2]; z(t) = SolHom[3] + SolNoHom[3];$

$$SolPart := x(t)=\frac{2\,t\,e^{t}}{3}+\frac{e^{3t}}{10}+\frac{47\,e^{t}}{18}-\frac{199\,e^{-2t}}{90}+\frac{5\,e^{2t}}{2}$$

$$y(t)=\frac{e^{3t}}{10}+\frac{2\,t\,e^{t}}{3}+\frac{11\,e^{t}}{18}-\frac{5\,e^{2t}}{2}-\frac{199\,e^{-2t}}{90}$$

$$z(t)=\frac{3\,e^{3t}}{10}+\frac{2\,t\,e^{t}}{3}+\frac{23\,e^{t}}{18}+\frac{199\,e^{-2t}}{45} \qquad (53)$$

>

> **restart:**

SOLUCIÓN

> **restart:**

FIN DE LA SERIE