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> restart
> Ecuacion := y''(x) - 7·y'(x) + 12·y(x) = 4·exp(3·x)
      Ecuacion :=  $\frac{d^2}{dx^2} y(x) - 7 \left( \frac{d}{dx} y(x) \right) + 12 y(x) = 4 e^{3x}$  (1)
> Condiciones := y(0) = 8, D(y)(0) = -6
      Condiciones := y(0) = 8, D(y)(0) = -6 (2)
> EcuacionHom := lhs(Ecuacion) = 0
      EcuacionHom :=  $\frac{d^2}{dx^2} y(x) - 7 \left( \frac{d}{dx} y(x) \right) + 12 y(x) = 0$  (3)
> Q := rhs(Ecuacion)
      Q :=  $4 e^{3x}$  (4)
> EcuacionCarac := m·2 - 7·m + 12 = 0
      EcuacionCarac :=  $m^2 - 7m + 12 = 0$  (5)
> Raiz := solve(EcuacionCarac)
      Raiz := 4, 3 (6)
> SolUno := y(x) = exp(Raiz1·x); SolDos := y(x) = exp(Raiz2·x)
      SolUno := y(x) =  $e^{4x}$ 
      SolDos := y(x) =  $e^{3x}$  (7)
> SolHom := y(x) = C1·rhs(SolUno) + C2·rhs(SolDos)
      SolHom := y(x) =  $C_1 e^{4x} + C_2 e^{3x}$  (8)
> SolNoHom := y(x) = A·rhs(SolUno) + B·rhs(SolDos)
      SolNoHom := y(x) =  $A e^{4x} + B e^{3x}$  (9)
> with(linalg) :
> AA := wronskian([rhs(SolUno), rhs(SolDos)], x)
      AA :=  $\begin{bmatrix} e^{4x} & e^{3x} \\ 4e^{4x} & 3e^{3x} \end{bmatrix}$  (10)
> BB := array([0, Q])
      BB :=  $\begin{bmatrix} 0 & 4e^{3x} \end{bmatrix}$  (11)
> SOL := simplify(linsolve(AA, BB)) : Aprima := SOL1; Bprima := SOL2
      Aprima :=  $4 e^{-x}$ 
      Bprima := -4 (12)
> A := int(Aprima, x) + C1; B := int(Bprima, x) + C2
      A :=  $-4 e^{-x} + C_1$ 
      B :=  $-4x + C_2$  (13)
> SolGral := simplify(SolNoHom)
      SolGral := y(x) =  $-4 e^{3x} + C_1 e^{4x} - 4 e^{3x} x + C_2 e^{3x}$  (14)
> Sistema := eval(subs(x=0, rhs(SolGral))) = rhs(Condiciones1), eval(subs(x=0,

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$$\begin{aligned} rhs(diff(SolGral, x)) &= rhs(Condiciones_2) : Sistema_1; Sistema_2 \\ -4 + C_1 + C_2 &= 8 \\ -16 + 4 C_1 + 3 C_2 &= -6 \end{aligned} \quad (15)$$

$$\begin{aligned} > Parametro := solve(\{Sistema\}, \{C_1, C_2\}) : Parametro_1; Parametro_2 \\ C_1 &= -26 \\ C_2 &= 38 \end{aligned} \quad (16)$$

$$\begin{aligned} > SolucionParticular := subs(C_1 = rhs(Parametro_1), C_2 = rhs(Parametro_2), SolGral) \\ SolucionParticular &:= y(x) = 34 e^{3x} - 26 e^{4x} - 4 e^{3x} x \end{aligned} \quad (17)$$

COMPROBANDO

$$\begin{aligned} > SolPart := dsolve(\{Ecuacion, Condiciones\}) \\ SolPart &:= y(x) = 34 e^{3x} - 26 e^{4x} - 4 e^{3x} x \end{aligned} \quad (18)$$

> restart

$$\begin{aligned} > Ecuacion := y'''' + y''' + y'' + y' + y = 0 \\ Ecuacion &:= \frac{d^4}{dx^4} y(x) + \frac{d^3}{dx^3} y(x) + \frac{d^2}{dx^2} y(x) + \frac{d}{dx} y(x) + y(x) = 0 \end{aligned} \quad (19)$$

$$\begin{aligned} > Caracteristica := m \cdot 4 + m \cdot 3 + m \cdot 2 + m + 1 = 0 \\ Caracteristica &:= m^4 + m^3 + m^2 + m + 1 = 0 \end{aligned} \quad (20)$$

$$\begin{aligned} > Raiz := solve(Caracteristica) : evalf(%, 3) \\ 0.310 + 0.948 I, -0.810 + 0.585 I, -0.810 - 0.585 I, 0.310 - 0.948 I \end{aligned} \quad (21)$$

$$\begin{aligned} > Condiciones := y(0) = 4, D(y)(0) = 2, D(D(y))(0) = 3, D(D(D(y)))(0) = -1 \\ Condiciones &:= y(0) = 4, D(y)(0) = 2, D^{(2)}(y)(0) = 3, D^{(3)}(y)(0) = -1 \end{aligned} \quad (22)$$

$$\begin{aligned} > SolPart := dsolve(\{Ecuacion, Condiciones\}) : evalf(%, 3) \\ y(x) &= 0.838 e^{-0.810x} \sin(0.585 x) + 4.76 e^{0.310x} \sin(0.948 x) + 3.80 e^{-0.810x} \cos(0.585 x) \\ &+ 0.215 e^{0.310x} \cos(0.948 x) \end{aligned} \quad (23)$$

$$\begin{aligned} > Sistema := diff(y_1(x), x) = y_2(x), diff(y_2(x), x) = y_3(x), diff(y_3(x), x) = y_4(x), diff(y_4(x), \\ x) &= -y_1(x) - y_2(x) - y_3(x) - y_4(x) : Sistema_1; Sistema_2; Sistema_3; Sistema_4 \end{aligned}$$

$$\frac{d}{dx} y_1(x) = y_2(x)$$

$$\frac{d}{dx} y_2(x) = y_3(x)$$

$$\frac{d}{dx} y_3(x) = y_4(x)$$

$$\frac{d}{dx} y_4(x) = -y_1(x) - y_2(x) - y_3(x) - y_4(x) \quad (24)$$

$$\begin{aligned} > Condiciones := y_1(0) = 4, y_2(0) = 2, y_3(0) = 3, y_4(0) = -1 \\ Condiciones &:= y_1(0) = 4, y_2(0) = 2, y_3(0) = 3, y_4(0) = -1 \end{aligned} \quad (25)$$

$$\begin{aligned} > SolPartDos := dsolve(\{Sistema, Condiciones\}) : evalf(SolPartDos_1, 3) \end{aligned} \quad (26)$$

$$y_1(x) = 4.73 \sin(0.952 x) e^{0.310x} + 3.78 \cos(0.588 x) e^{-0.810x} + 0.825 e^{-0.810x} \sin(0.588 x) + 0.20 \cos(0.952 x) e^{0.310x} \quad (26)$$

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

$$AA := \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -1 & -1 & -1 & -1 \end{bmatrix} \quad (27)$$

> with(linalg) :

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

$$0.729 e^{-0.810x} \cos(0.585 x) + 0.233 e^{-0.810x} \sin(0.585 x) + 0.379 e^{0.310x} \sin(0.948 x) + 0.276 e^{0.310x} \cos(0.948 x) + 0.372 I (0.003 e^{-0.810x} \sin(0.585 x) - 0.006 e^{0.310x} \sin(0.948 x) - 0.004 e^{0.310x} \cos(0.948 x)) \quad (28)$$

> Xcero := array([4, 2, 3, -1])

$$Xcero := \begin{bmatrix} 4 & 2 & 3 & -1 \end{bmatrix} \quad (29)$$

> Solucion := simplify(evalm(MatExp &* Xcero)) : evalf(Solucion[1, 3])

$$4.74 e^{0.310x} \sin(0.948 x) + 0.820 e^{-0.810x} \sin(0.585 x) + 0.210 e^{0.310x} \cos(0.948 x) + 3.80 e^{-0.810x} \cos(0.585 x) \quad (30)$$

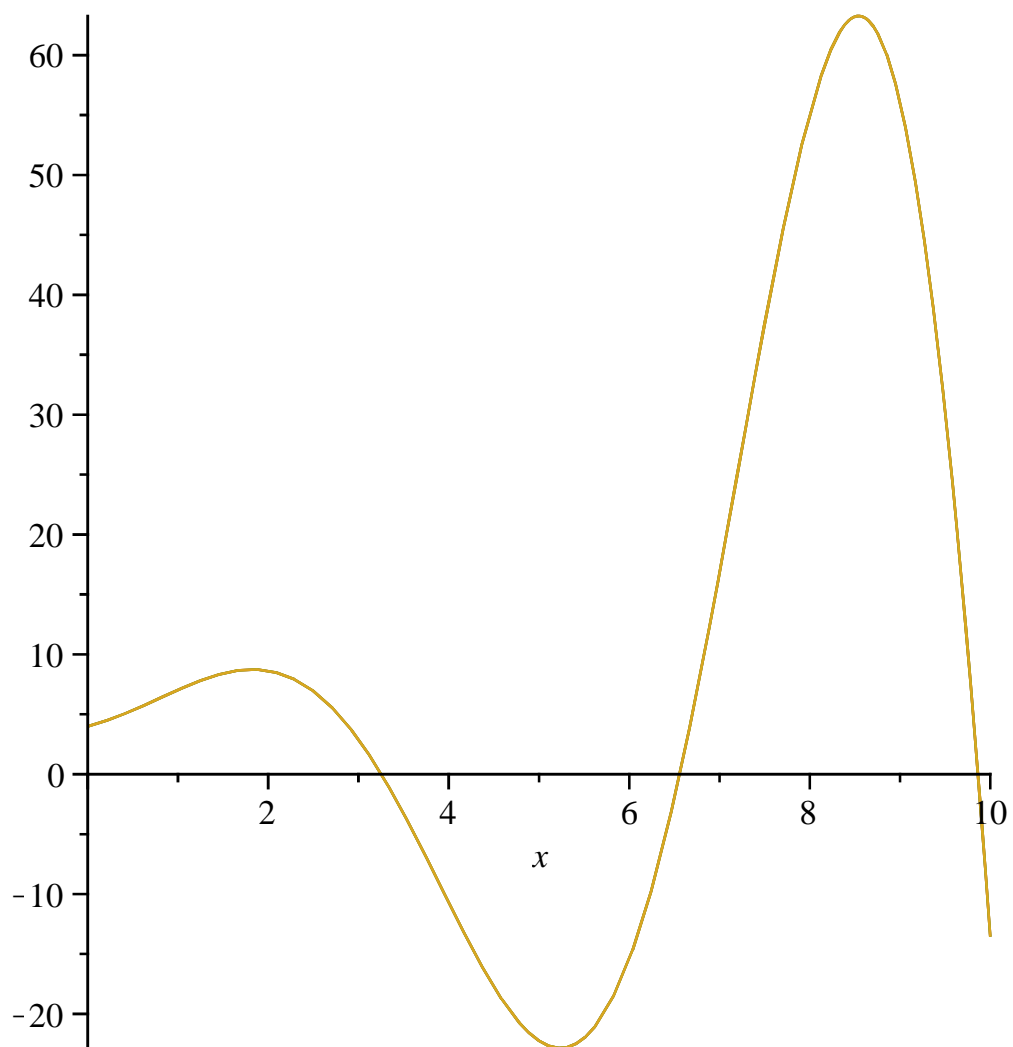
> evalf(SolPartDos[1, 3])

$$y_1(x) = 4.73 \sin(0.952 x) e^{0.310x} + 3.78 \cos(0.588 x) e^{-0.810x} + 0.825 e^{-0.810x} \sin(0.588 x) + 0.20 \cos(0.952 x) e^{0.310x} \quad (31)$$

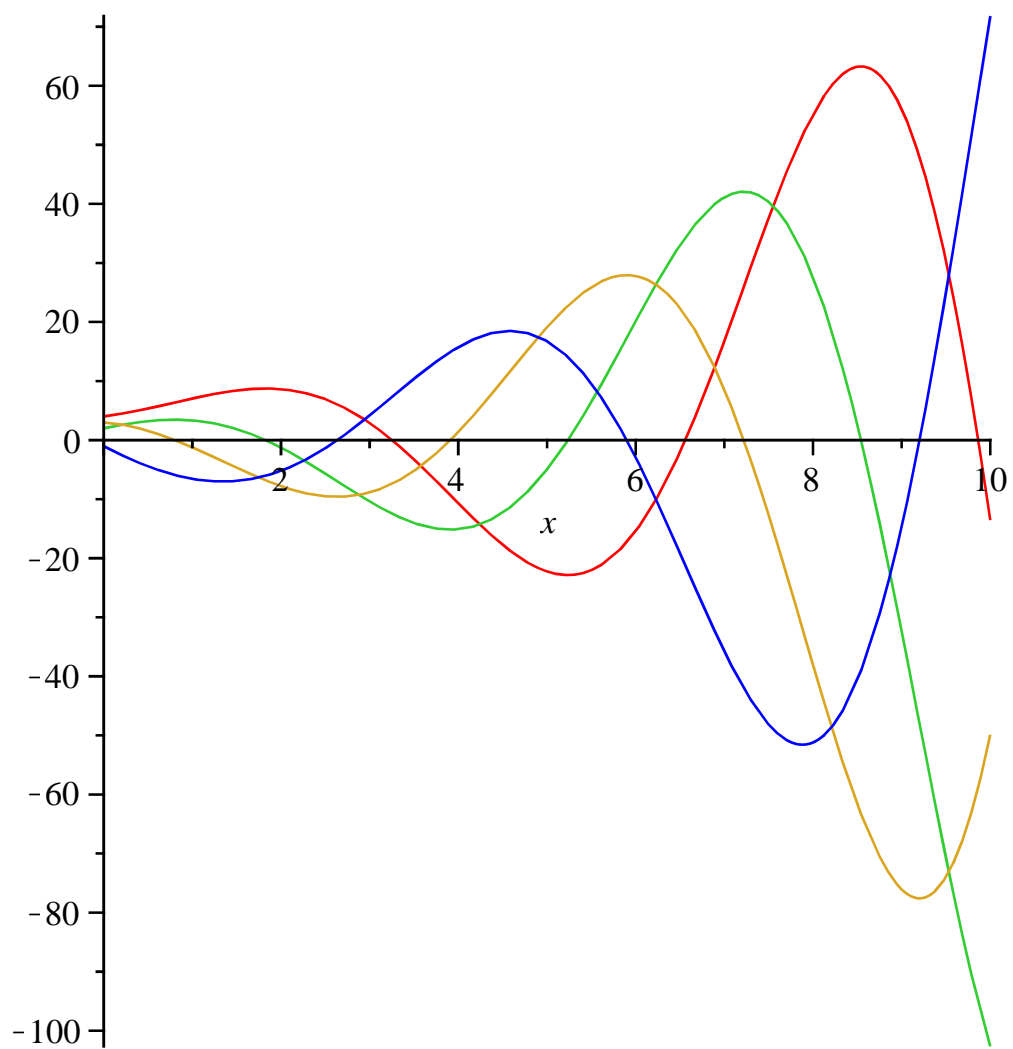
> evalf(SolPart, 3)

$$y(x) = 0.838 e^{-0.810x} \sin(0.585 x) + 4.76 e^{0.310x} \sin(0.948 x) + 3.80 e^{-0.810x} \cos(0.585 x) + 0.215 e^{0.310x} \cos(0.948 x) \quad (32)$$

> plot([Solucion[1, rhs(SolPart)], rhs(SolPartDos[1])], x=0..10)



`> plot([Solucion1, Solucion2, Solucion3, Solucion4], x=0..10)`



`> plot([Solucion1, Solucion2, Solucion3, Solucion4], x=0..2)`

