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Mechatronics Engineering

$$\frac{dy}{dx} + y\tanh x = 2\sinh x$$

$$\frac{dy}{dx} + \frac{y\sinh x}{\cosh x} = 2\sinh x$$

$$P = \frac{\sinh x}{\cosh x} \qquad e^{\int P dx} = e^{\ln\cosh x} = \cosh x.$$

$$\int P dx = \ln\cosh x$$

$$y \cdot IF = \int Q \cdot IF \, dx$$

$$y \times \cosh x = \int 2\sinh x \cosh x \, dx.$$

$$y \times \cosh x = \int \sinh(2x) \, dx$$

$$y \times \cosh x = +\tfrac{1}{2}\cosh(2x) + C$$

$$y \times \cosh x = \frac{1}{2}\cosh^2(x) + C$$

$$y = \frac{-1}{2\cosh x} + \cosh x + C(\cosh x)^{-1}$$

$$y = \frac{-1 + \cosh^2 x + 2C}{2\cosh(x)}$$

$$y = \frac{-1 + \cosh^2 x + A}{2\cosh x}$$

$$\frac{dy}{dx} + 2y = e^{3x}$$

$$P = 2 \qquad \int P dx = 2x \qquad IF = e^{\int P dx} = e^{2x}$$

$$IF \cdot y = \int Q \cdot IF \, dx$$

$$e^{2x} \cdot y = \int e^{2x} \cdot e^{3x} \, dx$$

$$e^{2x} \cdot y = \int e^{5x} \, dx$$

$$e^{2x} y = \frac{e^{5x}}{5} + C$$

$$y = e^{3x}/5 + Ce^{-2x}$$

$$x\frac{dy}{dx} = x^2 + 2x - 3$$

$$\cancel{x}\frac{dy}{dx} = x + 2 - 3/x$$

$$y = \int x + 2 - 3/x \, dx$$

$$y = \frac{x^2}{2} + 2x - 3\ln x + C$$

$$\frac{dy}{dx} + \frac{y}{x} = y^3 \qquad y^{-3}\frac{dy}{dx} + \frac{y^{-2}}{x} = 1$$

$$z = y^{1-3} = y^{-2}$$

$$\frac{dz}{dx} = -2y^{-3}\frac{dy}{dx}$$

$$-2y^{-3}\frac{dy}{dx} - \frac{2y^{-2}}{x} = -2$$

$$\frac{dz}{dx} - \frac{2z}{x} = -2$$

$$P = -2/x \quad \int P\,dx = -2\ln x = IF = e^{\int P\,dx} = e^{-2\ln x} = \frac{1}{x^2}$$

$$z \cdot IF = \int Q \cdot IF\,dx$$

$$z \cdot \frac{1}{x^2} = \int -2 \cdot \frac{1}{x^2}\,dx$$

$$z \cdot \frac{1}{x^2} = \frac{+2}{+1} \times \frac{1}{x} + c$$

$$\frac{z}{x^2} = \frac{2}{x} + C$$

$$z = 2x + Cx^2$$

$$\frac{1}{y^2} = 2x + cx^2$$

$$y^2 = \frac{1}{2x + cx^2}$$

$$y = \sqrt{\frac{1}{2x + cx^2}}$$

$$x^2 \frac{dy}{dx} = x^3 \sin 3x + 4.$$

$$\frac{dy}{dx} = x \sin 3x + 4x^{-2}$$

$$y = \int \overset{u}{x} \overset{dv}{\sin 3x} + 4x^{-2} \, dx.$$

$u = x$ $\quad dv = \sin 3x$

$du = 1$ $\quad v = -\frac{1}{3}\cos 3x$

$$uv - \int v \, du.$$

$$y = -\frac{1}{3} x \cos 3x - \int -\frac{1}{3}\cos 3x \, dx + \int 4x^{-2} \, dx$$

$$y = -\frac{1}{3} x \cos x + \frac{1}{9} \sin 3x + \left(-\frac{4}{x}\right)$$

$$y = -\frac{1}{3} x \cos x + \frac{1}{9} \sin 3x - \frac{4}{x}$$

$$(x^3 + xy^2) \frac{dy}{dx} = 2y^3$$

$$\frac{dy}{dx} = \frac{2y^3}{x^3 + xy^2}$$

$y = vx$ $\quad \frac{dy}{dx} = v + x\frac{dv}{dx}$

$$\frac{dy}{dx} = \frac{2v^3 x^3}{x^3 + v^2 x^3}$$

$$\frac{dy}{dx} = \frac{2v^3}{1 + v^2}$$

$$v + x\frac{dv}{dx} = \frac{2v^3}{1+v^2}$$

$$x\frac{dv}{dx} = \frac{2v^3 - v - v^3}{1+v^2}$$

$$x\frac{dv}{dx} = \frac{v^3 - v}{1+v^2}$$

$$\frac{1+v^2}{v^3-v}dv = \frac{1}{x}dx$$

$$\frac{1+v^2}{v(v^2-1)}dv = \frac{1}{x}dx$$

$$\frac{1+v^2}{v(v+1)(v-1)}dv = \frac{1}{x}dx$$

$$\frac{1+v^2}{v(v+1)(v-1)} = \frac{A}{v} + \frac{B}{v+1} + \frac{C}{v-1}$$

$$1+v^2 = Av^2 - A + Bv^2 - Bv + Cv^2 + Cv$$

v^2: $A+B+C = 1$ $\qquad -1+B+B = 1$

v: $-B+C = 0$ $\qquad 2B = 2$

$C = B$ $\qquad B = 1 = C$

v^0: $-A = 1$

$A = -1$

$$\int \frac{-1}{v} + \frac{1}{v+1} + \frac{1}{v-1}\,dx = \int \frac{1}{x}dx$$

$$-\ln v + \ln(v+1) + \ln(v+1) = \ln x + C$$

$$-\ln v + \ln(v+1) + \ln(v-1) = \ln x + \ln A$$

$$\ln\left(\frac{(v+1)(v-1)}{v}\right) = \ln(A\cdot x)$$

$$\frac{v^2-1}{v} = A\cdot x \qquad = \frac{y^2 - x^2}{x^2} = Ay$$

$$\frac{\frac{y^2}{x^2} - 1}{\frac{y}{x}} = Ax \qquad Ax^2y = y^2 - x^2$$

$$y^2 = Ax^2y + x^2 = x^2(Ay+1)$$