

Goodhead Ilegome Iwac
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 Mechanical Engineering

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

$$\frac{dy}{dx} + Py = Q$$

$P = \tanh x$, $Q = 2 \sin x$

Spolze

$$= \int \tanh x \cdot dx$$

$$I_f = \ln(\cosh x) = \cosh x$$

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

$$y \cdot I_f = \int Q \cdot I_f dx$$

$$y \cosh x = \int 2 \sin x \cosh x dx$$

$$y \cosh x = 2 \int \sin x \cosh x dx$$

$$y \cosh x = (\cosh^2 x) + C$$

$$y = \cosh x + \frac{C}{\cosh x}$$

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

$P = 2$

$Q = e^{3x}$

I_f $e^{Sp dx}$

$$\int P dx = \int 2 dx$$

$$I_f = e^{2x}$$

$$y \cdot I_f = \int Q \cdot I_f dx$$

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

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

$$y e^{2x} = \frac{e^{5x}}{5} + C \Rightarrow \frac{e^{3x}}{5} + \frac{C}{e^{2x}}$$

$$y = \frac{e^{3x}}{5} + \frac{C}{e^{2x}}$$

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

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

$$\int dy = \int \left(x + 2 - \frac{3}{x} \right) dx$$

$$y = \int \left(x + 2 - \frac{3}{x} \right) dx$$

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

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

$$\frac{dy}{dx} + Py = Qy^n$$

$P = \frac{1}{x}; Q = 1, n = 3$

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

$$Z = y^{1-n} = y^{-2}$$

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

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

$$Z.I.F = \int Q.I.F. dx$$

$$\int \frac{dy}{y} = \int \frac{1}{x} dx$$

Int

$$e^{\ln x} = x$$

$$Z.I.F = \int dx$$

$$Z.I.F = \frac{x^2}{2} + C$$

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

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

$$y = v_{oc} = N$$

$$x_{oc} = V \frac{y}{x} \sqrt{2} - 1 \sqrt{2} = A x$$

$$\frac{x_{oc}}{1 - \frac{x_{oc}}{V}} = \frac{y}{x} \sqrt{2} - 1$$

$$\frac{y}{x} = \frac{A x \sqrt{2}}{1 - \frac{A x \sqrt{2}}{V}} - 1 = A x$$

$$P_{oc} = \frac{V^2}{x_{oc}} = \frac{V^2}{A x}$$

$$P_{oc} = \frac{V^2}{x_{oc}} + (x_{oc} \sqrt{2})^2 = \frac{V^2}{x_{oc}} + 2 x_{oc}^2$$

$$\frac{dP_{oc}}{dx} = -\frac{V^2}{x^2} + 4 x_{oc} = 0$$

$$4 x_{oc} = \frac{V^2}{x^2}$$

$$x_{oc} = \frac{V^2}{4 x^2}$$

$$V_{oc} = \frac{V_{oc} x}{x_{oc}} = \frac{V_{oc} x}{\frac{V^2}{4 x^2}} = \frac{4 V_{oc} x^3}{V^2}$$

$$x_{oc} = \frac{V_{oc} x}{V^2} = \frac{V_{oc} x}{V^2} \sqrt{2} - 1 \sqrt{2}$$

$$\frac{V_{oc} x}{V^2} = \frac{V_{oc} x}{V^2} \sqrt{2} - 1 \sqrt{2}$$

$$\frac{V_{oc} x}{V^2} (1 - \sqrt{2}) = -1 \sqrt{2}$$

$$\frac{V_{oc} x}{V^2} = \frac{1 \sqrt{2}}{1 - \sqrt{2}}$$

$$\frac{V_{oc} x}{V^2} = \frac{1 \sqrt{2}}{1 - \sqrt{2}} \cdot \frac{1 + \sqrt{2}}{1 + \sqrt{2}} = \frac{1 \sqrt{2} (1 + \sqrt{2})}{1 - 2} = -\sqrt{2} (1 + \sqrt{2})$$

$$P_{oc} = \frac{V^2}{x_{oc}} = \frac{V^2}{\frac{V^2}{4 x^2}} = 4 x^2$$

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$$5 \quad x^2 \frac{dy}{dx} = x^3 \int \ln 3x + 4$$

$$\frac{dy}{dx} = x \int \ln 3x + \frac{4}{x^2}$$

$$\int dy = \int (x \ln 3x) + \int \frac{4}{x^2}$$

$$y = \frac{-x \cos 3x}{3} + \frac{4x}{-2+1} + C$$

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

$$6. (x^3 + xy^2) \frac{dy}{dx} = 2y^3$$

$$y = y_0 e^{\int \frac{dy}{y} dx}$$

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

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$$\frac{dy}{dx} = \frac{2y^3}{x^3(1+y^2)}$$

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

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

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

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

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

$$x \frac{dy}{dx} = \frac{y(y^2 - 1)}{1+y^2}$$

$$x \frac{dy}{dx} = \frac{y(y-1)(y+1)}{1+y^2}$$

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$$u = 2x \quad du = 1$$

$$dy = 3 \ln 3x \quad y = \frac{-\cos 3x}{3}$$

$$-\frac{\cos 3x}{3} - \int \frac{\cos 3x}{3} - 1$$

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

$$\frac{1+y^2}{y^3-y} = \frac{1+y^2}{y(y^2-1)} = \frac{1+y^2}{y(y-1)(y+1)}$$

$$= \frac{A}{y} + \frac{B}{y-1} + \frac{C}{y+1}$$

$$1+y^2 = A(y-1)(y+1) + B(y)(y+1)$$

$$(y-1) + C(y)(y-1)$$

$$\text{when } y=1, C=1$$

$$\text{when } y=-1, B=1$$

$$\text{when } y=0, A=-1$$

$$\therefore \int \frac{-1}{y} + \int \frac{1}{y+1} + \int \frac{1}{y-1}$$

$$= -\ln y + \ln(y+1) + \ln(y-1) =$$

$$-\ln y + \ln(y+1) + \ln(y-1) =$$

$$\ln x + \ln A \quad \text{where } C = \ln(A)$$

$$\ln \left[\frac{(y+1)(y-1)}{y} \right] = \ln(Ax)$$

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