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1. $2y\,dx - x\,dy = 0$ $\qquad y = ux$

$2y\,dx = x\,dy$ $\qquad y' = xu' + u$

$2y/x = dy/dx$

$xu' + u = 2u \Rightarrow x\,du + u\,dx = 2u\,dx$

$x\,du = u\,dx$

$\frac{du}{u} = \frac{dx}{x}$

$\int \frac{du}{u} = \int \frac{dx}{x}$

$\ln|u| = \ln|x| + \ln c$

$\ln|y| - \ln|x| = \ln|x| + \ln c$

$\ln|y| = \ln|x^2| + \ln c$

$\ln|y| = \ln|cx^2|$

$y = cx^2$

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

$y = ux$ $\qquad =$

$y' = xu' + u$

$xu' + u = \frac{x^2}{2xy} + \frac{3y^2}{2xy} = \frac{x}{2y} + \frac{3y}{2x}$

$2(xu' + u) = \frac{x}{y} + \frac{3y}{x}$

$= \frac{1}{u} + 3u$

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$2xv' + 2v = \frac{1+3v^2}{v}$

$2xv' = \frac{1+v^2}{v}$

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

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

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

$\frac{1}{2}\ln|1+v^2| = \frac{1}{2}\ln|x| + \ln c$

$\ln|1+y^2/x^2| = \ln|xc|$

$y^2/x^2 = xc - 1$

$y^2 = (xc-1)(x^2)$

$y = \pm(x^3c - x^2)^{1/2}$

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

$y = vx$

$y' = xv' + v$

$xv' + v = \frac{y^2}{x^2} + \frac{2xy}{x^2} \Rightarrow xv' + v = v^2 + 2v$

$xv' = v^2 + v$

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

$y = vx$

$y' = xv' + v$

$xv' + v = \frac{x+3vx}{x-vx}$

$xv' = \frac{x+3vx-vx+v^2x}{x-vx}$

$= \frac{x+2vx+v^2x}{x-vx}$

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

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

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

$\frac{-2}{v+1} - \ln|v+1| = \ln|x| + \ln|c|$

$\frac{-2}{v+1} = \ln\left|xc\left(\frac{y}{x}+1\right)\right|$

$\frac{-2}{\frac{y+x}{x}} = \ln|cy+cx|$

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$$-2\left(\frac{x}{y+x}\right) = \ln|cy+cx|$$

$$\frac{x}{y+x} = \ln|cy+cx|^{-1/2}$$

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

$y = vx$

$y' = xv' + v$

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

$xv' + v = 1 + v + v^2$

$xv' = 1 + v^2$

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

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

$\arctan(v) = \ln|x| + c$

$\arctan\left(\frac{y}{x}\right) = \ln|x| + c$

$\frac{y}{x} = \tan(\ln|x| + c)$

$y = \tan(\ln|x| + c)x$

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1. $y^2 + xy = e^{-x}$

$P(x) = 2 \qquad r(x) = e^{-x}$

$2dx = 2x + c$

$y = e^{-2x}\left(\int e^{2x} e^{-x}\, dx + c\right)$

$= e^{-2x}\left(\int e^{x}\, dx + c\right)$

$= e^{-x} + ce^{-2x} \Rightarrow$ SU

2. $(x+1)y' + y = x^2 - 1$

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

$P(x) = \frac{1}{x+1} \Rightarrow h(x) = \int \frac{1}{x+1}\, dx \Rightarrow \ln(x+1)$

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$$y = e^{-\ln(x+1)} \left( \int (x+1) \frac{-x^2-1}{(x+1)} \, dx + c \right)$$

$$= \frac{1}{x+1} \left( \frac{x^3}{3} - x + c \right) \Rightarrow$$

$$= \frac{x^3}{3(x+1)} - \frac{x}{x+1} + \frac{c}{x+1} \Rightarrow SU$$

3. $y' + y \tan x = \sec x$

$$P(x) = \tan x \Rightarrow h(x) = \int \tan x \, dx = -\ln|\cos(x)|$$

$$y = e^{\ln|\cos(x)|} \left( \int e^{-\ln|\cos(x)|} \sec x \, dx + c \right)$$

$$= \cos(x) \left( \int \frac{\sec(x)}{\cos(x)} \, dx + c \right)$$

$$= \cos(x) \left( \int \frac{1}{\cos(x)} \, dx + c \right)$$

$$= \cos(x) \tan(x) + c \cos(x) \Rightarrow SU$$

4. $y' + \frac{2y}{x+1} = (x+1)^2$

$$P(x) = \frac{2}{x+1} \Rightarrow h(x) = 2 \int \frac{1}{x+1} \, dx = 2\ln|x+1| + c$$

$$y = e^{-\ln|x+1|^2} \left( \int e^{\ln|x+1|^2} (x+1)^2 \, dx + c \right)$$

$$= \frac{1}{(x+1)^2} \left( \int (x+1)^2 (x+1)^2 \, dx + c \right)$$

$$= \frac{1}{(x+1)^2} \left( \int v' \, dv + c \right)$$

$$= \frac{1}{(x+1)^2} \left( \frac{v^5}{5} + c \right) \Rightarrow \frac{v^5}{5(x+1)^2} + \frac{c}{(x+1)^2}$$

$$= \frac{(x+1)^5}{5(x+1)^2} + \frac{c}{(x+1)^2} \Rightarrow SU$$

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9. $y' = e^{2x} - 3y$

$y(0) = 1$

$P(x) = 3 \Rightarrow h(x) = \int 3\,dx = 3x + C$

$y = e^{-3x}\left(\int e^{3x} e^{2x}\,dx + c\right)$

$= e^{-3x}\left(\int e^{5x}\,dx + c\right)$

$= e^{-3x}\left(\frac{1}{5} e^{5x} + c\right)$

$= \frac{e^{2x}}{5} + e^{-3x} \cdot c \Rightarrow$ SU

$1 = \frac{e^2}{5} + \frac{c}{e^3}$ $\qquad 5e^3 = e^5 + 5c$ $\qquad y = \frac{e^{2x}}{5} + \frac{5e^3 - e^5}{5e^{3x}} \Rightarrow$ SU

$1 = \frac{e^5 + 5c}{5e^3}$ $\qquad 5c = 5e^3 - e^5$

$c = \frac{5e^3 - e^5}{5}$