Mon Tue Wed Thu Fri Sat Sun Date:

$\partial f/\partial x$ $\partial f/\partial y$

$$(e^{2y} - y\cos xy)dx + (2xe^{2y} - x\cos xy + 2y)dy = 0$$

Step # 1: $M = e^{2y} - y\cos xy$ | $N = 2xe^{2y} - x\cos xy + 2y$

$$\frac{\partial M}{\partial y} = 2(e^{2y}) - \{y[-\sin xy(x) + \cos xy(1)]\}$$

$$\frac{\partial N}{\partial x} = 2e^{2y}(1) - \{x[-\sin xy(y)] + \cos xy(1)\} + 0$$

$$\frac{\partial M}{\partial y} = 2e^{2y} + xy\sin xy - \cos xy$$

$$\frac{\partial N}{\partial x} = 2e^{2y} + xy\sin xy - \cos xy$$

As it holds the property of differential Equation

Step # 2: $M = e^{2y} - y\cos xy$

$$\frac{\partial f}{\partial x} = e^{2y} - y\cos xy$$

$$\int \frac{\partial f}{\partial x} = \int (e^{2y} - y\cos xy)\partial x$$

$$f = \int e^{2y}\partial x - \int y\cos xy\,\partial x$$

$$f = e^{2y}\int 1dx - y\int \cos xy\,dx$$

$$f = x.e^{2y} - y.\frac{\sin xy}{y} + C$$

$$f = x.e^{2y} - \cancel{y}.\frac{\sin xy}{\cancel{y}} + g(y)$$

$$f = xe^{2y} - \sin xy + g(y) \longrightarrow eq^{u}(A)$$

Step # 3:

$$\frac{\partial f}{\partial y} = xe^{2y}(2) - \cos(xy)(x) + g'(y)$$

$$\frac{\partial f}{\partial y} = (2xe^{2y} - x\cos xy + g'(y))$$

$$\cancel{2xe^{2y}} - \cancel{x\cos xy} + 2y = \cancel{2xe^{2y}} - \cancel{x\cos xy} + g'(y)$$

$$g'(y) = 2y$$

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Date:

Step # 4: $\int (g'(y))\partial y = \int (2y)\partial y$

$$g(y) = 2\int y\,dy$$

$$g(y) = 2\left(\frac{y^2}{2}\right)$$

$$g(y) = y^2 \quad \rightarrow \quad \text{equ}(B)$$

Put equ(B) in Equ(A)

$$f = xe^{2y} - \sin xy + g(y)$$

$$f(x,y) = xe^{2y} - \sin xy + y^2$$

$$C = xe^{2y} - \sin xy + y^2 \qquad \because C = f(x,y)$$

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