

Cálculo Diferencial e Integral en Varias Variables

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Ejercicio 1

Consigna

Hallar la solución general de las siguientes ecuaciones diferenciales de variables separables:

1. $y' = y^2 - 1$
2. $(1 + y^2)yy' + (1 + y^2) = 0$
3. $xe^{2y}y' - (1 + e^{2y}) = 0$

Resolución

Parte 1

- $y' = y^2 - 1$

$$\begin{aligned}
y' &= y^2 - 1 \\
&\iff \\
\frac{y'}{y^2 - 1} &= 1 \\
&\iff \\
\int \frac{y'}{y^2 - 1} dx &= \int 1 dx \\
&\iff (u=y(x), du=y'(x)dx) \\
\int \frac{1}{u^2 - 1} du &= x + k_1 \\
&\iff (\text{fracciones simples}) \\
\int \frac{1}{2} \left(\frac{1}{u-1} - \frac{1}{u+1} \right) du &= x + k_1 \\
&\iff \\
\frac{1}{2} \left(\int \frac{1}{u-1} du - \int \frac{1}{u+1} du \right) &= x + k_1 \\
&\iff \\
\frac{1}{2} (\ln|u-1| + k_2 - \ln|u+1| + k_3) &= x + k_1 \\
&\iff (C_1 = \frac{1}{2}(k_2 + k_3)) \\
\frac{1}{2} \ln \left| \frac{u-1}{u+1} \right| + C_1 &= x + k_1 \\
&\iff (C_2 = 2k_1 - C_1) \\
\ln \left| \frac{u-1}{u+1} \right| &= 2x + C_2 \\
&\iff \\
\frac{u-1}{u+1} &= \pm e^{2x+C_2} \\
&\iff (K = \pm e^{\frac{C_2}{2}}) \\
\frac{u-1}{u+1} &= Ke^{2x} \\
&\iff \\
u-1 &= Ke^{2x}(u+1) \\
&\iff \\
u-1 &= Ke^{2x}u + Ke^{2x} \\
&\iff \\
u - Ke^{2x}u &= Ke^{2x} + 1 \\
&\iff \\
u(1 - Ke^{2x}) &= Ke^{2x} + 1 \\
&\iff (\text{suponemos que } 1 - Ke^{2x} \neq 0) \\
u &= \frac{1 + Ke^{2x}}{1 - Ke^{2x}} \\
&\iff (\text{deshago cambio de variable}) \\
y(x) &= \frac{1 + Ke^{2x}}{1 - Ke^{2x}}
\end{aligned}$$

Parte 2

- $(1 + y^2)yy' + (1 + y^2) = 0$

$$(1 + y^2)yy' + (1 + y^2) = 0$$

$$\Longleftrightarrow (\forall x \in \mathbb{R}: (1 + y^2) > 0)$$

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

$$\Longleftrightarrow$$

$$y'y = -1$$

$$\Longleftrightarrow$$

$$\int y' y dx = \int -1 dx$$

$$\Longleftrightarrow (u=y(x); du=y'(x)dx)$$

$$\int u du = -x + k_1$$

$$\Longleftrightarrow$$

$$\frac{u^2}{2} = -x + k_1$$

$$\Longleftrightarrow (C=k_1-k_2)$$

$$u = \sqrt{2}\sqrt{-x + C}$$

$$\Longleftrightarrow (\text{deshago cambio de variable})$$

$$y(x) = \sqrt{2}\sqrt{-x + C}$$

Parte 3

- $xe^{2y}y' - (1 + e^{2y}) = 0$

$$xe^{2y}y' - (1 + e^{2y}) = 0$$

$$\Leftrightarrow$$

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

$$\Leftrightarrow$$

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

$$\Leftrightarrow$$

$$\int \frac{e^{2y}y'}{1 + e^{2y}} dx = \int \frac{1}{x} dx$$

$$\Leftrightarrow (u=y(x); du=y'(x)dx)$$

$$\int \frac{e^{2u}}{1 + e^{2u}} du = \ln|x| + k_1$$

$$\Leftrightarrow (\text{preparando otro cambio de variable})$$

$$\frac{1}{2} \int \frac{2e^{2u}}{1 + e^{2u}} du = \ln|x| + k_1$$

$$\Leftrightarrow (v=1+e^{2u}; dv=2e^{2u}du)$$

$$\frac{1}{2} \int \frac{dv}{v} = \ln|x| + k_1$$

$$\Leftrightarrow$$

$$\frac{1}{2} \ln|v| + k_2 = \ln|x| + k_1$$

$$\Leftrightarrow (\text{deshago cambios de variable})$$

$$\frac{1}{2} \ln|1 + e^{2y}| + k_2 = \ln|x| + k_1$$

$$\Leftrightarrow (C=2(k_1-k_2))$$

$$\ln|1 + e^{2y}| = 2\ln|x| + C$$

$$\Leftrightarrow (n \cdot \ln(x) = \ln(x^n) \text{ y } (1+e^{2y}) > 0)$$

$$1 + e^{2y} = e^{\ln|x|^2 + C}$$

$$\Leftrightarrow (x^2 > 0 \text{ y } K = e^C)$$

$$1 + e^{2y} = Kx^2$$

$$\Leftrightarrow$$

$$e^{2y} = Kx^2 - 1$$

$$\Leftrightarrow$$

$$2y = \ln(Kx^2 - 1)$$

$$\Leftrightarrow$$

$$y = \frac{1}{2} \ln(Kx^2 - 1)$$