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40. $x^3 \frac{d^3 y}{dx^3} + 2x^2 \frac{d^2 y}{dx^2} - x \frac{dy}{dx} + y = 12x^2$; $y = c_1 x + c_2 x \ln x + 4x^2$, $x > 0$

Solución:

$$x^3 \frac{d^3 y}{dx^3} + 2x^2 \frac{d^2 y}{dx^2} - x \frac{dy}{dx} + y = 12x^2 \Leftrightarrow x^3 \frac{d^3 y}{dx^3} + 2x^2 \frac{d^2 y}{dx^2} - x \frac{dy}{dx} + y - 12x^2 = 0 \quad (\star)$$

$$y = c_1 x + c_2 x \ln x + 4x^2 \quad (1),$$

$$\Rightarrow \frac{dy}{dx} = c_1 + c_2 \ln x + c_2 + 8x \quad (2),$$

$$\Rightarrow \frac{d^2 y}{dx^2} = \frac{c_2}{x} + 8 \quad (3),$$

$$\Rightarrow \frac{d^3 y}{dx^3} = -\frac{c_2}{x^2} \quad (4)$$

Sustituyendo (1), (2), (3) y (4) en (\star), se obtiene:

$$x^3 \left(-\frac{c_2}{x^2} \right) + 2x^2 \left(\frac{c_2}{x} + 8 \right) - x(c_1 + c_2 \ln x + c_2 + 8x) + c_1 x + c_2 x \ln x + 4x^2 - 12x^2 = 0,$$

$$\Rightarrow -c_2 x + 2c_2 x^2 + 16x^2 - c_1 x - c_2 x \ln x - c_2 x - 8x^2 + c_1 x + c_2 x \ln x + 4x^2 - 12x^2 = 0,$$

$$\Rightarrow -2c_2 x + 2c_2 x^2 + 20x^2 - 20x^2 = 0.$$

Ejercicios 1.2

En los problemas 1 a 10, determine una región del plano xy para la cual la ecuación diferencial dada tenga una solución única que pase por un punto (x_0, y_0) en la región.

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

Solución:

$$\left. \begin{array}{l} \frac{dy}{dx} = y^{2/3} \\ (x_0, y_0) \end{array} \right\} \quad (1)$$

De (1) se deduce que:

$$f(x, y) = y^{2/3} : f \text{ es continua } \forall (x, y) \in \mathbb{R}$$

$$\frac{\partial f}{\partial y} = \frac{2}{3y^{1/3}} : \frac{\partial f}{\partial y} \text{ es discontinua en } y = 0.$$

Conclusión: en cualquier semiplano $y > 0$ ó $y < 0$ existe un intervalo abierto centrado en x_0 en el cual el problema con valor inicial (1) tiene una única solución.

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