

EXAMPLE:

$$\frac{d^2 y}{dx^2} + 3 \frac{d^2 y}{dx^2} - 4y = xe^x$$

$$\frac{d^2 y}{dx^2} + 3 \frac{d^2 y}{dx^2} - 4y = 0$$

$$y = u = c_1 e^x + c_2 e^{-2x} + c_3 x e^{-2x}$$

differentiate to get $\frac{d^3 y}{dx^3} + 3 \frac{d^3 y}{dx^3} - 4 \frac{dy}{dx} = xe^x + e^x$

subtract to get $\frac{d^3 y}{dx^3} + 2 \frac{d^3 y}{dx^3} - 3 \frac{d^3 y}{dx^3} - 4 \frac{dy}{dx} + 4y = e^x$

differentiate to get $\frac{d^4 y}{dx^4} + 2 \frac{d^4 y}{dx^4} - 3 \frac{d^4 y}{dx^4} - 4 \frac{d^2 y}{dx^2} + 4 \frac{dy}{dx} = e^x$

subtract to get $\frac{d^4 y}{dx^4} + \frac{d^4 y}{dx^4} - 5 \frac{d^4 y}{dx^4} - \frac{d^2 y}{dx^2} + 8 \frac{dy}{dx} - 4y = 0$

let $y = e^{rx}$, so $r^4 + r^4 - 5r^4 - r^2 + 8r - 4 = 0$

$$(r-1)(r+2)(r+2)(r-1)(r-1) = 0$$

so, $y = u + v = c_1 e^x + c_2 e^{-2x} + c_3 x e^{-2x} + c_4 x e^x + c_5 x^2 e^x$

$$y = v = e^x (c_4 x + c_5 x^2)$$

differentiate to get $\frac{dy}{dx} = e^x (c_4 + (c_4 + 2c_5)x + c_5 x^2)$

$$\frac{d^2 y}{dx^2} = e^x (2(c_4 + c_5) + (c_4 + 4c_5)x + c_5 x^2)$$

$$\frac{d^3 y}{dx^3} = e^x (3c_4 + 6c_5 + (c_4 + 6c_5)x + c_5 x^2)$$

$$9c_4 + 12c_5 + 18c_5 x = x$$

equate coefficients of like terms to get

$$9c_4 + 12c_5 = 0 \text{ and } 18c_5 = 1$$

$$\text{so, } c_4 = \frac{1}{18}, c_5 = -\frac{2}{27}$$

COMPLETE SOLUTION:

$$y = u + v = c_1 e^x + c_2 e^{-2x} + c_3 x e^{-2x} - \frac{2}{27} x e^x + \frac{1}{18} x^2 e^x$$

Computer Methods In Solution Of Differential Equations

Puja Mehta

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Advances in Computer Methods for Partial Differential Equations II Robert Vichnevetsky, 1977

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