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$$y = e^{x^2+x}$$

$$y' = (2x+1)e^{x^2+x}$$

$$y'' = 2e^{x^2+x} + (2x+1)(2x+1)e^{x^2+x}$$

$$y'' = 2e^{x^2+x} + (2x+1)e^{x^2+x}$$

$$\therefore y'(2x+1) + 2y$$

$$= (2x+1)e^{x^2+x} + 2e^{x^2+x}$$

$$\text{but } y'' = 2e^{x^2+x} + 2e^{x^2+x}$$

$$\therefore y'' = y'(2x+1) + 2y$$

From the above equation,

Part A

$$A = y'', A' = y''', A^{(n)} = y^{(2n)}$$

part B

$$B = y'(2x+1)$$

$$u = y', u^* = y^{n+1}$$

$$v = 2x+1$$

$$v' = 2$$

$$v''' = 0$$

$$\therefore B^n = (y^{n+1})(2x+1) + 2n(y^n)(2) + 0$$

$$B^n = (2x+1)2y^{n+1} + 2ny^n$$

part C

$$C = 2y$$

$$C^n = 2y^n$$

$$\therefore A^n = B^n + C^n$$

$$y^{n+2} = (2x+1)y^{n+1} + 2ny^n + 2y^n$$

$$y^{n+2} = (2x+1)y^{n+1} + 2y^n(n+1) \Rightarrow$$

$$\therefore y^{(n+2)} = (2x+1)y^{(n+1)} + 2(n+1)y^n$$

$$y = x^3 e^{4x}$$

using Leibnitz Theorem
 $u = e^{4x}$, $u' = 4e^{4x}$, $u'' = 16e^{4x}$, $u''' = 64e^{4x}$, $u^{iv} = 256e^{4x}$

$$v = x^3, v' = 3x^2, v'' = 6x, v''' = 6, v^{iv} = 0$$

Hence $u^n = 4^n e^{4x}$

$$y^n = u^n v + n u^{n-1} v' + \frac{n(n-1)}{2!} u^{n-2} v'' + \frac{n(n-1)(n-2)}{3!} u^{n-3} v''' +$$

$$\frac{n(n-1)(n-2)(n-3)}{4!} u^{n-4} v^{iv} +$$

$$y^n = 4^n e^{4x} (x^3) + n 4^{n-1} e^{4x} (3x^2) + \frac{n(n-1)}{2!} 4^{n-2} e^{4x} (6x) + \frac{n(n-1)(n-2)}{3!} 4^{n-3} e^{4x} (6) +$$

$$\frac{n(n-1)(n-2)(n-3)}{4!} 4^{n-4} (0)^2$$

$$y^n = 4^n x^3 e^{4x} + n 3x^2 4^{n-1} e^{4x} + 3xn(n-1) 4^{n-2} e^{4x} + n(n-1)(n-2) 4^{n-3} e^{4x} + 0$$

$$y^n = e^{4x} 4^{n-3} (20x^3 + 3nx^2 \cdot 4^2 + 3xn(n-1) 4^{4-2} + n(n-1)(n-2))$$

$$y^n = e^{4x} 4^{n-3} (64x^3 + 48x^2 n + 12xn(n-1) + n(n-1)(n-2)) - (y^n)$$

$$y^5 = e^{4x} 4^{5-3} (64x^3 + 48x^2(5) + (12x \cdot 5(5-1) + 5(5-1)(5-2)))$$

$$y^5 = e^{4x} 4^2 (64x^3 + 240x^2 + 240x + 36)$$

$$y^5 = 16e^{4x} (64x^3 + 240x^2 + 240x + 36)$$

$$\frac{x^2 d^2 y}{dx^2} + \frac{ny}{dx} + y = 0$$

$$x^2 y'' + ny' + y = 0$$

$$w_1 + w_2 + w_3 = 0$$

$$w_1 = x^2 y''$$

$$u = y''', u' = y^{iv}, u'' = y^v, u''' = y^v \text{ hence } u^n = y^{n+2}$$

$$v = x^2, v' = 2x, v'' = 2, v''' = 0$$

$$w_1 = u^n (v) + n u^{n-1} v' + \frac{n(n-1)}{2!} u^{n-2} (v^{iv}) + \frac{n(n-1)(n-2)}{3!} u^{n-3} v^{v} + \dots$$

$$u^{n-3} v^{v} + \dots$$

$$w_1 = y^{n+2} (x^2) + n y^{n+1} (2x) + \frac{n(n-1)}{2} y^n (2) + 0.$$

$$w_1 = x^2 y^{n+2} + 2xny^{n+1} + y^n n(n-1)$$

$$w_2 = xy'$$

$$u = y', \quad u' = y'', \quad u'' = y''' \quad \text{Have } u'' = y^{2n+6}$$

$$v = x \quad v' = 1 \quad v'' = 0$$

$$w_2 = y^{n+1}(x) + ny^n(1) + 0$$

$$w_2 = xy^{n+1} + ny^n$$

$$w_3 = y$$

$$u = y \quad u' = y' \quad \text{Here } u^n = y^n$$

$$v = 1 \quad v' = 0$$

$$w_3 = u^n(v) + nu^{n-1}(v')$$

$$= y(1) \neq 0 = y$$

$$w_1 + w_2 + w_3 = 0$$

$$y^{n+2}(n^2) + ny^{n+1}(2x) + n(n-1)y^n + xy^{n+1} + ny^n + y^n = 0$$

$$x^2 y^{n+2} + 2xy^{n+1}(2n+1) + y^n(n(n-1) + n+1)$$

$$x^2 y^{n+2} + 2xy^{n+1}(2n+1) + y^n(n^2+1) = 0$$