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$H = y^n(n^2 - n + n + 1) + y^{n+1}(n2x + x) + x^2 y^{n+2}$

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

Hence

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

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(2) $y = x^3 e^{4x}$

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

then

$v^0 = x^3$

$v' = 3x^2$

$v'' = 6x$

$v''' = 6$

and $u^0 = e^{4x}$

$u' = 4e^{4x}$

$u'' = 16e^{4x}$

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

From

$$y^n = u^n v^0 + n u^{n-1} v' + \frac{(n-1) n u^{n-2} v''}{2!} + \frac{(n-2)(n-1)(n) u^{(n-3)} v'''}{3}$$

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

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

If then "y^5"

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

$$y^5 = 1024 e^{4x} x^3 + 3840 x^2 e^{4x} + 3840 e^{4x} + 960 e^{4x}$$

CONTINUATION OF 1

$W_3 = (-2x+1)y'$

$u^0 = y'$

$u^n = y^{n+1}$

$v^0 = -2x+1$

$v' = -2$

$W_3 = u^n v^0 + n u^{n-1} v'$

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

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

$W_1 + W_2 + W_3$

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

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

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

17/1/18

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

$u = x^2 + x$

$\frac{du}{dx} = 2x+1$

$y = e^u$

$\frac{dy}{du} = e^u$

$\frac{dy}{dx} = e^u 2x+1$

$\frac{dy}{dx} = (e^{x^2+x})(2x+1)$

Product rule

$\frac{dy}{dx} = \underset{u}{e^{x^2+x}} \quad \underset{v}{2x+1}$

$\frac{d^2y}{dx} = e^{x^2+x}(2) + (2x+1)\underbrace{(e^{x^2+x})(2x+1)}_{\frac{dy}{dx}}$

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

then

$y'' = 2y + (2x+1)\frac{dy}{dx} \quad = 2y + (2x+1)y'$

Hence

$\frac{d^2y}{dx^2} - 2y - (2x+1)y' = 0$

$w_1'' \quad w_2 \quad w_3$

i) $w_1 = \frac{d^2y}{dx^2}$

$V_0 = 1 \quad ; u^0 = y''$

$V' = 0 \quad u^n = y^{n+2}$

Hence

$u^nV^0 + nu^{n-1}V' + \ldots$

$= y^{n+2}.1 + ny^{n+2-1}.0$

$= y^{n+2}$

ii) $w_2 = -2y$

$V^0 = -2$

$u^0 = y^0$

$u^n = y^n$

hence

$= u^nV^0 + nu^{n-1}V'$

$= y^n.-2 + ny^{n-1}.0$

$= -2y^n$