HIGHER ORDER DERIVATIVES

Note Title 3/5/2014

IE GIVEN $f(x) = 6x^4 + 5x^9 - 7x$ FIND

A) $f'(x)$ = 1^{ST} DERIVATIVE = VELOCITY

B) $f''(x)$ = 2^{ND} DERIVATIVE = ACCELERATION

C) $f'''(x)$ = 3^{RD} DERIVATIVE = JERK

D) $f^{(iv)}(x)$ = 4^{TH} " = SNAP

E) $f^{(v)}(x)$ = 5^{TH} "

SOL'N A) $f'(x) = 24x^3 + 45x^8 - 7$

B) $f''(x) = 72x^2 + 360x^7$

c) $f'''(x) = 144x + 2520x^6$

d) $f^{(iv)}(x) = 144 + 15120x^5$

E) $f^{(v)}(x) = 75600x^4$

- THE OTHER NOTATION

$$y \quad , \quad \frac{dy}{dx} \quad , \quad \frac{d^2y}{dx^2} \quad , \quad \frac{d^3y}{dx^3} \quad , \ldots \quad \frac{d^ny}{dx^n}$$

FUNCTION, 1ST DERIVATIVE, 2ND, 3RD, nTH DERIVATIVE

EX $y = \sqrt{x}$ FIND $\dfrac{d^3y}{dx^3}$

SOLN $\dfrac{dy}{dx} = \dfrac{1}{2}x^{-\frac{1}{2}}$

$$\frac{d^2y}{dx^2} = -\frac{1}{4}x^{-\frac{3}{2}}$$

$$\frac{d^3y}{dx^3} = \frac{3}{8}x^{-\frac{5}{2}}$$

IE A GRADE 10 STUDENT FLYING OUT A WINDOW HAS POSITION $x(t) = -4.9t^2 + 9t + 23$

FIND $a(t)$

SOLN $x'(t) = v(t) = -9.8t + 9$

$x''(t) = v'(t) = a(t) = -9.8 \ m/s^2$

IE A STUDENT IS RUNNING ACROSS THE FLOOR, HIS POSITION IS GIVEN BY THE FUNCTION

$$P(x) = -3x^3 + 7x^2 + \sqrt{x}$$

FIND HIS ACCELERATION AT $x = 2$ SECS.

<u>SOLN</u>

$$v(x) = -9x^2 + 14x + \frac{1}{2}x^{-\frac{1}{2}}$$

$$a(x) = -18x + 14 - \frac{1}{4}x^{-\frac{3}{2}}$$

$$a(2) = -18(2) + 14 - \frac{1}{4}(2)^{-\frac{3}{2}}$$

$$a(2) = -22.088 \ m/s^2$$

<u>IE</u> FIND $f''(x)$ WHEN $f(x) = (2x^2+6x+9)^3$

<u>SOLN</u>

$$f'(x) = 3(2x^2+6x+9)^2(4x+6)$$

$$f'(x) = (12x+18)(2x^2+6x+9)^2$$

$$f''(x) = (12)(2x^2+6x+9)^2 + \underbrace{2(2x^2+6x+9)(4x+6)(12x+18)}_{\text{FOIL}}$$

x

IE $y = (4x^5+5x^3)^4$ Find $y''(x)$

SOLN

$$y' = 4(4x^5+5x^3)^3\overbrace{(20x^4+15x^2)}^{2^{\text{nd}}}$$

$$y'' = 12\underbrace{(4x^5+5x^3)^{2}}(20x^4+15x^2)(20x^4+15x^2) + (80x^3+30x)(4(4x^5+5x^3)^3$$

$$y'' = 4(4x^5+5x^3)^2\left[3\underbrace{(20x^4+15x^2)^2}_{\text{FOIL}} + \underbrace{(80x^3+30x)(4x^5+5x^3)}_{\text{FOIL}}\right]$$

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