1)

$$x^2$$

$$f'(x) = \frac{-f(x+2h)+4f(x+h)-3f(x)}{2h}$$

$$\lim_{h\to 0} \frac{-(x+2h)^2 + 4(x+h)^2 - 3x^2}{2h}$$

$$\lim_{h\to 0} \frac{-(x^2+4xh+4h^2)+4(x^2+2xh+h^2)-3x^2}{2h}$$

$$\lim_{h\to 0} \frac{4xh}{2h}$$

$$\lim_{h\to 0} 2x$$

$$2x = \frac{d}{dx}(x^2) \quad \checkmark$$

$$x^2$$

$$f''(x) = \frac{f(x+h) - 2f(x) + f(x-h)}{h^2}$$

$$\lim_{h\to 0} \frac{(x+h)^2 - 2x^2 + (x-h)^2}{h^2}$$

$$\lim_{h\to 0} \frac{\cancel{x^2} + \cancel{2xh} + h^2 - \cancel{2x^2} + \cancel{x^2} - \cancel{2xh} + h^2}{h^2}$$

$$\lim_{h\to 0} \frac{2h^2}{h^2}$$

$$\lim_{h\to 0} 2$$

$$2 = \frac{d^2}{dx^2}(x^2)$$

$\sin(x)$

$$f'(x) = \frac{-f(x+2h)+4f(x+h)-3f(x)}{2h}$$

$$\lim_{h\to 0} \frac{-\sin(x+2h)+4\sin(x+h)-3\sin(x)}{2h}$$

$$\lim_{h\to 0} \frac{-\left(\sin(x)\cos(2h)+\cos(x)\sin(2h)\right)+4\left(\sin(x)\cos(h)+\cos(x)\sin(h)\right)-3\sin x}{2h}$$

$$\lim_{h\to 0} \frac{\sin(x)\left(-\cos(2h)+4\cos(h)-3\right)+\cos(x)\left(-\sin(2h)+4\sin(h)\right)}{2h}$$

$$\lim_{h\to 0} \sin(x)\frac{4\cos(h)-\cos^2(h)+\sin^2(h)-3\sin^2(h)-3\cos^2(h)}{2h}+\cos(x)\frac{4\sin(h)-2\sin(h)\cos(h)}{2h}$$

$$\lim_{h\to 0} \sin(x)\frac{4\cos(h)\left(1-\cos(h)\right)-2\sin^2(h)}{2h}+\cos(x)\frac{\sin(h)}{h}\left(2-\cos(h)\right)$$

$$\lim_{h\to 0} 2\sin(x)\cos(h)\frac{1-\cos^2(h)}{h(1+\cos(h))} - \lim_{h\to 0}\sin(h)\lim_{h\to 0}\frac{\sin(h)}{h} + \lim_{h\to 0}\cos(x)\frac{\sin(h)}{h}\lim_{h\to 0}(2-\cos(h))$$

$$\lim_{h\to 0} 2\sin(x)\cos(h)\frac{\sin(h)}{h}\lim_{h\to 0}\frac{\sin(h)}{1+\cos(h)} - 0 + \cos(x)$$

$$0 \qquad + \quad \cos(x)$$

$$\cos(x) = \frac{d}{dx}\left(\sin(x)\right) \checkmark$$

$\sin(x)$

$$f''(x) = \frac{f(x+h) - 2f(x) + f(x-h)}{h^2}$$

$$\lim_{h \to 0} \frac{\sin(x+h) - 2\sin(x) + \sin(x-h)}{h^2}$$

$$\lim_{h \to 0} \frac{\sin(x)\cos(h) + \sin(h)\cos(x) - 2\sin(x) + \sin(x)\cos(h) - \sin(h)\cos(x)}{h^2}$$

$$\lim_{h \to 0} \frac{2\sin(x)(\cos(h) - 1)}{h^2}$$

$$\lim_{h \to 0} 2\sin(x)\frac{\cos^2(h) - 1}{h^2(\cos(h)+1)}$$

$$\lim_{h \to 0} 2\sin(x)\frac{-\sin^2(h)}{h^2(\cos(h)+1)}$$

$$\lim_{h \to 0} -2\sin(x)\frac{\sin(h)}{h} \lim_{h \to 0} \frac{\sin(h)}{h} \lim_{h \to 0} \frac{1}{\cos(h)+1}$$

$$-\sin(x) = \frac{d^2}{dx^2}(\sin(x)) \checkmark$$