Applications of Derivatives – Formula Sheet:

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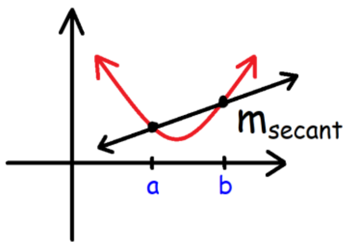

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Average Rate of Change:

$$m_{secant} = \frac{f(b) - f(a)}{b - a}$$

Tangent Line Equation:

$$y - y_1 = m(x - x_1)$$

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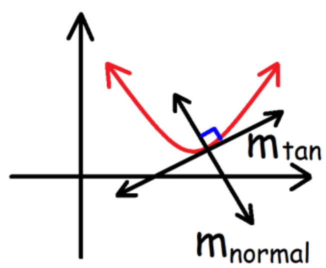

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Instantaneous Rate of Change:

$$m_{tangent} = f'(c)$$

The Normal Line:

$$m_{normal} = -\frac{1}{m_{tangent}}$$

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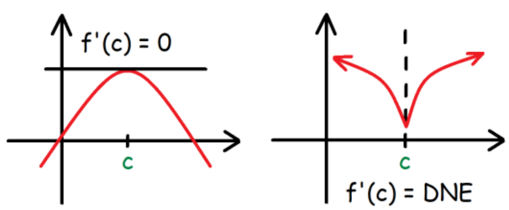

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Critical Points:

$$f'(c) = 0 \quad or \quad f'(c) = DNE$$

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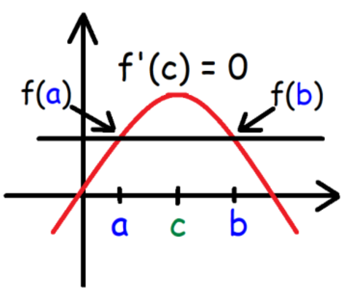

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Rolle's Theorem:

1. $f(x)$ *is continuous on* $[a, b]$
2. $f(x)$ *is differentiable on* (a, b)
3. $f(a) = f(b)$

If the 3 conditions above are met, then there is a number c in (a, b) where $f'(c) = 0$.

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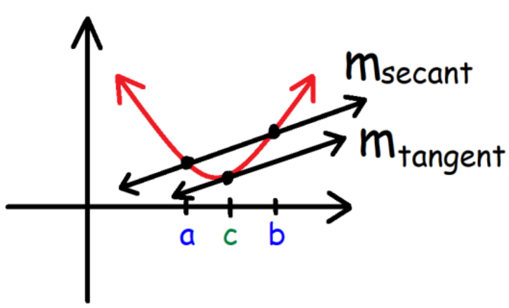

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Mean Value Theorem:

If f(x) is continuous on [a, b] and differentiable on (a, b), then there is a number c in (a, b) such that

$$f'(c) = \frac{f(b) - f(a)}{b - a}$$

$$m_{tangent} = m_{secant}$$

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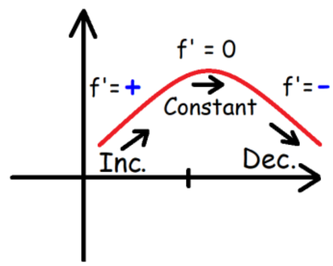
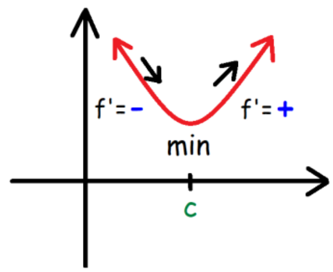
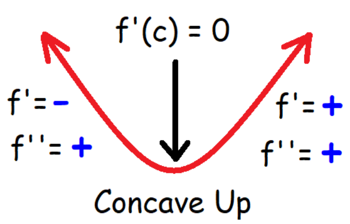
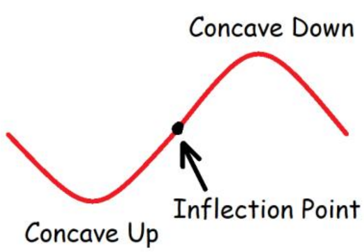
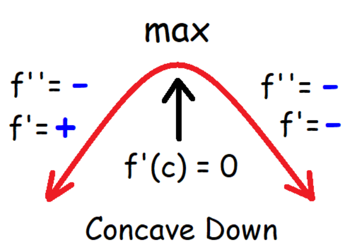
	**Increasing/Decreasing Test:** 1. $f(x)$ is increasing when $f'(x) > 0$. 2. $f(x)$ is decreasing when $f'(x) < 0$. 3. If $f'(x)$ does not change sign at c, then $f(x)$ has no relative minimum or maximum at c.
	**First Derivative Test:** 1. If f' changes from $+$ to $-$ at c, then f has a local max. at c. 2. If f' changes from $-$ to $+$ at c, then f has a local min. at c. 3. If f' doesn't change sign at c, then f has no local min. or max. at c.
	**Concavity Test:** 1. f is concave up when $f''(x) > 0$ or when $f'(x)$ is increasing. 2. f is concave down when $f''(x) < 0$ or when $f'(x)$ is decreasing.
	**Inflection Points:** If $f''(c) = 0$ or $f''(c)$ does not exist, then there is an inflection point at c if the concavity changes at c. Note: f must be continuous near c.
	**Second Derivative Test:** 1. If $f'(c) = 0$ and $f''(c) > 0$, then f has a relative minimum at c. 2. If $f'(c) = 0$ and $f''(c) < 0$, then f has a relative maximum at c. Note: f'' must be continuous near c.
L'hospital's Rule: $\lim_{x \to a} \frac{f(x)}{g(x)} = \lim_{x \to a} \frac{f'(x)}{g'(x)}$ Note: $g'(x) \neq 0$ near $x = a$.	**Newton's Method for Approximating the Zeros of a Function:** $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$

Differentials: $$\boldsymbol{dy} = f'(x)\,dx$$ dx → Differential of x dy → Differential of y **Note:** $\Delta x = dx \;\; and \;\; \Delta y \approx dy$ $$\Delta \boldsymbol{y} = y_2 - y_1 = f(a + \Delta x) - f(a)$$	**Tangent Line Approximations:** $Point\ (a, f(a))$ $$y = f(a) + f'(a)(x - a)$$ **Linear Equation – Point Slope Form:** $Point\ (x_1, y_1)$ $$y - y_1 = m(x - x_1)$$ **Note:** $m = f'(a) \quad a = x_1 \quad f(a) = y_1$
Description: C(x) → Cost Function c(x) → Average Cost Function C'(x) → Marginal Cost Function **Note:** $c(x)\ is\ a\ minimum\ when\ C'(x) = c(x)$	**Average Cost Function:** $$\boldsymbol{c(x)} = \frac{C(x)}{x}$$
Revenue Function: $$\boldsymbol{R(x)} = x \cdot p(x)$$ **Note:** $p(x)\ is\ the\ price\ (demand) function.$	**Profit Function:** $$\boldsymbol{P(x)} = R(x) - C(x)$$ **Note:** $Max\ profit\ occurs\ when\ R'(x) = C'(x)$
Description: R'(x) → Marginal Revenue P'(x) → Marginal Profit C'(x) → Marginal Cost	**Marginal Profit:** $$\boldsymbol{P'(x)} = R'(x) - C'(x)$$
Average Velocity: $$\bar{v} = \frac{s(b) - s(a)}{b - a}$$	**Average Acceleration:** $$\bar{a} = \frac{v(b) - v(a)}{b - a}$$
Instantaneous Velocity: $$v(t) = s'(t)$$	**Instantaneous Acceleration:** $$a(t) = v'(t)$$
Displacement: $$d = s(b) - s(a)$$	**The Position Function:** $$s(t)$$