

Limits

[2] Precise Definition of a Limit Let f be a function defined on some open interval that contains the number a , except possibly at a itself. Then we say that the **limit of $f(x)$ as x approaches a is L** , and we write

$$\lim_{x \rightarrow a} f(x) = L$$

if for every number $\epsilon > 0$ there is a number $\delta > 0$ such that

$$\text{if } 0 < |x - a| < \delta \quad \text{then } |f(x) - L| < \epsilon$$

One Sided Limits

Show that the side you are evaluating exists

If it is defined @ value plug it in

First/ Second Derivative Tests

First	Second
1. Take derivative and find $c.v.$	1. Take and find $c.v.$
2. Use a sign chart	2. Use a sign chart
+ is inc. / - is dec.	+ is CC up / - is CC down
shows extrema	shows inflection points
* test endpoints	*if checking extrema sign is the opposite

Area Between Curves

$$A = \int_a^b (f(x) - g(x)) dx$$

$$A = \int_a^b (\text{top} - \text{bottom}) dx$$

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Derivative of an Integral

$$\frac{d}{dx} \int_{g(x)}^{h(x)} f(t) dt = f(h(x)) h'(x) - f(g(x)) g'(x)$$

Limit Definition of Derivatives

$$\frac{dy}{dx} = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$m = \lim_{x \rightarrow a} \frac{f(x) - f(a)}{x - a}$$

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Power Rule

$$\frac{d}{dx} x^n = n \cdot x^{n-1}$$

Product/Quotient Rule

$$\text{Product Rule: } \frac{d}{dx} [f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$$

$$\text{Quotient Rule: } \frac{d}{dx} \left[\frac{f(x)}{g(x)} \right] = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}$$

Chain Rule

$$\frac{d}{dx} [f(g(x))] = f'(g(x)) \cdot g'(x)$$

Intermediate Value Theorem

IF f is a function that is continuous over the interval $[a, b]$ and m is some number between $f(a)$ and $f(b)$, THEN there exists a number c between a and b such that $f(c) = m$.

Mean Value Theorem

Let f be continuous on $[a, b]$ and differentiable on (a, b) . Then there exists a point c in (a, b) such that

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

Rolle's Theorem

IF:

- $[a, b]$ is continuous
- (a, b) is differentiable
- $f(a) = f(b)$

THEN: $f'(c) = 0$

Newton Raphson Method

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Related Rates

1. Draw a picture and label
2. Use formula for area/volume of shape
3. Take derivative of formula
4. Plug in values to each formula as needed

*One variable will **NOT** have a rate of change (ex. ladder)

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