1. Differencial calculas.

Rolle's Mean value theorem :-

Statement :- If $f(x)$ is a function defined on $[a, b]$

(frist condition) Statement 1 :- $f(x)$ is contineous on $[a, b]$.

(second condition) Statement 2 :- $f(x)$ is differentiable on (a, b).

(third condition) Statement 3 :- $f(a) = f(b)$.

$\therefore$ Then their exists $c \in (b, a)$ such that
$$f'(c) = 0$$

Note :-
1. polynomial function is always contineous and differenciable.
2. exponencial function e^x, a^x are always contineous as well as differentiable
3. $\sin x, \cos x$ are contineous as well as differentiable
4. Every constant function is always differenciable and contineous.

Lagranges Mean Value theorem :- (LMVT)

Statement :- If $f(x)$ is a function defined on $[a, b]$.

Condition 1 :- $f(x)$ is contineous on $[a, b]$.

Condition 2 :- $f(x)$ is differenciable on (a, b).

$\therefore$ Then their exists $c \in (a, b)$ such that
$$f'(c) = \frac{f(b) - f(a)}{b - a}.$$

Cauchy's Mean Value Theorem :- (CMVT).

Statement :- Let $f(x), g(x)$ be two functions defined on $[a, b]$

Condition 1 :- If $f(x)$ and $g(x)$ are contineous on $[a, b]$.

Condition 2 :- If $f(x)$ and $g(x)$ are differenciable on (a, b).

Condition 3 :- $g'(x) \neq 0 \ \forall x$

$\therefore$ Then There Exists $c \in (a, b)$ such That.

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

Taylor's Series & Macllaren's Series.

(1) If $f(x)$ is susessively differenciable then The Tailors Series of $f(x)$ at $x = a$ or Taylor's Series expansion of $f(x)$ in asending power of $(x-a)$ expansion.

$$f(x) = f(a) + \frac{(x-a)}{1!} f'(a) + \frac{(x-a)^2}{2!} f''(a) + \cdots$$

(2) $f(x+h)$ Taylor's Series Expansion of $(x+h)$ in asending powers of h.

$$f(x) = f(x) + f'(x)\frac{h}{1!} + f''(x)\frac{h^2}{2!} + f'''(x)\frac{h^3}{3!} + \cdots$$

(3) $f(x+h)$ Taylor's Series Expansion of $(x+h)$ in asending powers of x.

$$f(x) = f(h) + f'(h)\frac{x}{1!} + f''(h)\frac{x^2}{2!} + \cdots$$

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Macleran's series! (only for $x=0$).

$$f(x) = f(0) + \frac{x}{1!} f'(0) + \frac{x^2}{2!} f''(0) + \frac{x^3}{3!} f'''(0) + \dots$$

Formula's for Macleran's Series!-

(1) $e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots$

(2) $e^{-x} = 1 - \frac{x}{1!} + \frac{x^2}{2!} - \frac{x^3}{3!} + \frac{x^4}{4!} + \dots$

(3) $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \dots$

(4) $\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} + \dots$

(5) $\tan x = x + \frac{x^3}{3!} + \frac{2x^5}{15} + \dots$

(6) $\sinh x = x + \frac{x^3}{3!} + \frac{x^5}{5!} + \dots$

(7) $\cosh x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \dots$

(8) $\tanh x = x - \frac{x^3}{3!} + \frac{2x^5}{15} + \dots$

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(9) $(1+x)^{-1} = 1 - x + x^2 - x^3 + \cdots$

(10) $(1-x)^{-1} = 1 + x + x^2 + x^3 + \cdots$

(11) $\tan^{-1} x = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \cdots$

(12) $\log(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \cdots$

(13) $\log(1-x) = -x - \frac{x^2}{2} - \frac{x^3}{3} - \cdots$

L' Hospital Rule :-

L'H Rule is only applicable for $\left(\frac{0}{0}, \frac{\infty}{\infty}\right)$

$$\lim_{x \to a} \frac{f(x)}{g(x)} = \lim_{x \to a} \frac{f'(x)}{g'(x)}$$

(1) $\lim_{x \to 0} \frac{\sin x}{x} = 1$ (2) $\lim_{x \to 0} \frac{a^x - 1}{x} = \log a$

(3) $\lim_{x \to 0} \frac{\tan x}{x} = 1$ (4) $\lim_{x \to 0} \frac{\sin^{-1} x}{x} = 1$

(5) $\lim_{x \to 0} \frac{\tan^{-1} x}{x} = 1$ (6) $\lim_{x \to 0} (1+x)^{1/x} = e$