(1) $If\ \lim_{x\to a} f(x)$ , $then\ put\ x-a=h.\quad Then\ \lim_{x\to a} f(x) = \lim_{h\to 0} f(a+h)$

(2) $If\ \lim_{x\to \infty} f(x),\quad then\ put\ \frac{1}{x}=z.\quad Then\ \lim_{x\to\infty} f(x) = \lim_{z\to 0} f\left(\frac{1}{z}\right)$

**(8) L'Hospital's Rule**

$If\ a\ function\ is\ in\ the\ form$

$\frac{0}{0}, \frac{\infty}{\infty}, \infty-\infty, 0\times\infty, 0^0, \infty^0, 1^\infty\ at\ x=a\ then\ f(x) is\ indeterminate\ at\ x=a.$

**Case I** $\left(\frac{0}{0}\right)$

$If\ \lim_{x\to a} f(x) = 0\ \&\ \lim_{x\to a} g(x) = 0$

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

**Case II** $\left(\frac{\infty}{\infty}\right)$

$If\ \lim_{x\to a} f(x) = \infty\ \&\ \lim_{x\to a} g(x) = \infty$

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

# CONTINUITY & DIFFERENTIABILITY

**Continuity:-**

f(x) is said to be continuous at x=a if

(i) f(a) is defined that means f(x) approaches to a definite finite value at x=a
(ii) $\lim_{x\to a} f(x) exists$
(iii) $\lim_{x\to a} f(x) = f(a)$

In brief, f(x) is said to be continuous at x=a if

$$\lim_{x\to a+} f(x) = \lim_{x\to a-} f(x) = f(a)$$

If one of the above condition fails, then f(x) is discontinuous at x=a.

If f(x) is continuous at every point in the interval $a \le x \le b$ then f(x) is continuous in the interval $a \le x \le b$.

**Differentiability:-**

Let the domain of definition of a function f(x) is D & $(a,b) \in D$.

f(x) is said to be differentiable at x=c ($where\ a < c < b$) iff

$$\lim_{x\to c}\frac{f(x)-f(c)}{x-c}\ exists\ \&\ approaches\ to\ a\ finite\ value.$$

$Differentiability => Continuity$