SOME IMPORTANT MATHEMATICAL FORMULAE

Circle : Area = πr^2; Circumference = $2\pi r$.
Square : Area = x^2 ; Perimeter = 4x.
Rectangle: Area = xy ; Perimeter = 2(x+y).

Triangle : Area = $\frac{1}{2}$(base)(height) ; Perimeter = a+b+c.

Area of equilateral triangle = $\frac{\sqrt{3}}{4}a^2$.

Sphere : Surface Area = $4\pi r^2$; Volume = $\frac{4}{3}\pi r^3$.

Cube : Surface Area = $6a^2$; Volume = a^3.

Cone : Curved Surface Area = πrl ; Volume = $\frac{1}{3}\pi r^2 h$
Total surface area = $\pi r l + \pi r^2$
Cuboid : Total surface area = 2 (ab + bh + lh); Volume = lbh.
Cylinder : Curved surface area = $2\pi rh$; Volume = $\pi r^2 h$
Total surface area (open) = $2\pi rh$;

Total surface area (closed) = $2\pi rh + 2\pi r^2$.

SOME BASIC ALGEBRAIC FORMULAE:

1. $(a + b)^2 = a^2 + 2ab + b^2$.
2. $(a - b)^2 = a^2 - 2ab + b^2$.
3. $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$.
4. $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$.
5. $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$.
6. $(a + b + c)^3 = a^3 + b^3 + c^3 + 3a^2b + 3a^2c + 3b^2c + 3b^2a + 3c^2a + 3c^2a + 6abc$.
7. $a^2 - b^2 = (a + b)(a - b)$.
8. $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$.
9. $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$.
10. $(a + b)^2 + (a - b)^2 = 4ab$.
11. $(a + b)^2 - (a - b)^2 = 2(a^2 + b^2)$.
12. If a + b + c = 0, then $a^3 + b^3 + c^3 = 3abc$.

INDICES AND SURDS

1. $a^m a^n = a^{m+n}$ 2. $\frac{a^m}{a^n} = a^{m-n}$. 3. $(a^m)^n = a^{mn}$ 4. $(ab)^m = a^m b^m$.

5. $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$. 6. $a^0 = 1,\ a \neq 0$. 7. $a^{-m} = \frac{1}{a^m}$. 8. $a^x = a^y \Rightarrow x = y$

9. $a^x = b^x \Rightarrow a = b$ 10. $\sqrt{a \pm 2\sqrt{b}} = \sqrt{x} \pm \sqrt{y}$, where x + y = a and xy = b.

LOGARITHMS

$a^x = m \Rightarrow \log_a m = x$ ($a > 0$ and $a \neq 1$)

1. $\log_a mn = \log m + \log n$.
2. $\log_a \left(\frac{m}{n}\right) = \log m - \log n$.
3. $\log_a m^n = n \log m$.
4. $\log_b a = \frac{\log a}{\log b}$.
5. $\log_a a = 1$.
6. $\log_a 1 = 0$.
7. $\log_b a = \frac{1}{\log_a b}$.
8. $\log_a 1 = 0$.
9. $\log (m + n) \neq \log m + \log n$.
10. $e^{\log x} = x$.
11. $\log_a a^x = x$.

PROGRESSIONS

ARITHMETIC PROGRESSION

a, a + d, a+2d,-----------------------------are in A.P.

n^{th} term, $T_n = a + (n-1)d$.

Sum to n terms, $S_n = \frac{n}{2}[2a + (n-1)d]$.

If a, b, c are in A.P, then $2b = a + c$.

GEOMETRIC PROGRESSION

a, ar, ar^2 ,--------------------------- are in G.P.

Sum to n terms, $S_n = \frac{a(1-r^n)}{1-r}$ if $r < 1$ and $S_n = \frac{a(r^n-1)}{r-1}$ if $r > 1$.

Sum to infinite terms of G.P, $S_\infty = \frac{a}{1-r}$.

If a, b, c are in A.P, then $b^2 = ac$.

HARMONIC PROGRESSION

Reciprocals of the terms of A.P are in H.P

$\frac{1}{a}, \frac{1}{a+d}, \frac{1}{a+2d}$, ----------------- are in H.P

If a, b, c are in H.P, then $b = \frac{2ac}{a+c}$.

MATHEMATICAL INDUCTION

$1 + 2 + 3 +$ -----------------$+n = \sum n = \frac{n(n+1)}{2}$.

$$1^2+2^2+3^2+\text{-----------------}+n^2=\sum n^2=\frac{n(n+1)(2n+1)}{6}.$$

$$1^3+2^3+3^3+\text{----------------}+n^3=\sum n^3=\frac{n^2(n+1)^2}{4}.$$

PERMUTATIONS AND COMBINATION

$$nP_r=\frac{n!}{(n-r)!}.$$

$$nC_r=\frac{n!}{r!(n-r)!}.$$

$n!=1.2\,3.\text{--------}n.$

$nC_r = nC_{n-r}.$

$nC_r + nC_{r-1} = (n+1)C_r.$

$$(m+n)C_r=\frac{(m+n)!}{m!n!}.$$

BINOMIAL THEOREM

$$(x+a)^n = x^n + nC_1x^{n-1}a + nC_2x^{n-2}a^2 + nC_3x^{n-3}a^3 + \text{------------} + nC_na^n.$$

n^{th} term, $T_{r+1} = nC_r\,x^{n-r}a^r$.

PARTIAL FRACTIONS

$\frac{f(x)}{g(x)}$ is a proper fraction if the deg $(g(x)) > \deg(f(x))$.

$\frac{f(x)}{g(x)}$ is a improper fraction if the deg $(g(x)) \le \deg(f(x))$.

1. Linear non- repeated factors

$$\frac{f(x)}{(ax+b)(cx+d)}=\frac{A}{ax+b}+\frac{B}{(cx+d)}.$$

2. Linear repeated factors

$$\frac{f(x)}{(ax+b)(cx+d)^2}=\frac{A}{ax+b}+\frac{B}{(cx+d)}+\frac{C}{(cx+d)^2}.$$

3. Non-linear(quadratic which can not be factorized)

$$\frac{f(x)}{(ax^2+b)(cx^2+d)}=\frac{Ax+B}{ax^2+b}+\frac{Cx+D}{(cx^2+d)}.$$

ANALYTICAL GEOMETRY

1. Distance between the two points (x_1, y_1) and (x_2, y_2) in the plane is

$$\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}\quad\text{OR}\quad\sqrt{(x_1-x_2)^2+(y_1-y_2)^2}.$$

2. Section formula

$$\left(\frac{mx_2+nx_1}{m+n},\frac{my_2+ny_1}{m+n}\right)\text{ (for internal division),}$$

$$\left(\frac{mx_2-nx_1}{m-n},\frac{my_2-ny_1}{m-n}\right)\text{ (for external division).}$$

3. Mid point formula
$$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right).$$

4. Centriod formula
$$\left(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3}\right).$$

5. Area of triangle when their vertices are given, $\frac{1}{2}\sum x_1(y_2 - y_3)$
$$= \frac{1}{2}\left[x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)\right]$$

STRAIGHT LINE

Slope (or Gradient) of a line = tangent of an inclination = tanθ.
Slope of a X- axis = 0
Slope of a line parallel to X-axis = 0
Slope of a Y- axis = ∞
Slope of a line parallel to Y-axis = ∞
Slope of a line joining (x_1, x_2) and (y_1, y_2) = $\frac{y_2 - y_1}{x_2 - x_1}$.

If two lines are parallel, then their slopes are equal ($m_1 = m_2$)

If two lines are perpendicular, then their product of slopes is -1 ($m_1\ m_2 = -1$)

EQUATIONS OF STRAIGHT LINE

1. $y = mx + c$ (slope-intercept form) $y - y_1 = m(x-x_1)$ (point-slope form)

$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$ (two point form)

$\frac{x}{a} + \frac{y}{b} = 1$ (intercept form)

$x\cos\alpha + y\sin\alpha = P$ (normal form)

Equation of a straight line in the general form is $\mathbf{ax^2 + bx + c = 0}$

Slope of $ax^2 + bx + c = 0$ is $-\left(\frac{a}{b}\right)$

2. Angle between two straight lines is given by, $\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right|$

Length of the perpendicular from a point (x_1,x_2) and the straight line $ax^2 + bx + c = 0$ is $\left|\frac{ax_1 + by_1 + c}{\sqrt{a^2 + b^2}}\right|$

Equation of a straight line passing through intersection of two lines $a_1x^2 + b_1x + c_1 = 0$ and $a_2x^2 + b_2x + c_2 = 0$ is $a_1x^2 + b_1x + c_1 + K(a_2x^2 + b_2x + c_2) = 0$, where K is any constant.

Two lines meeting a point are called intersecting lines.

More than two lines meeting a point are called concurrent lines.

Equation of bisector of angle between the lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ is $\frac{a_1x + b_1y + c_1}{\sqrt{a_1^2 + b_1^2}} = \pm \frac{a_2x + b_2y_2 + c_2}{\sqrt{a_2^2 + b_2^2}}$

PAIR OF STRAIGHT LINES

1. An equation $ax^2 + 2hxy + by^2 = 0$, represents a pair of lines passing through origin generally called as homogeneous equation of degree2 in x and y and angle between these is given by $\tan\theta = \left|\frac{2\sqrt{h^2 - ab}}{a + b}\right|$.

   $ax^2 + 2hxy + by^2 = 0$, represents a pair of coincident lines, if $h^2 = ab$ and the same represents a pair of perpendicular lines, if $a + b = 0$.

   If m_1 and m_2 are the slopes of the lines $ax^2 + 2hxy + by^2 = 0$, then $m_1 + m_2 = -\frac{2h}{b}$ and $m_1 m_2 = \frac{a}{b}$.

2. An equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ is called second general second order equation represents a pair of lines if it satisfies the the condition $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$.

   The angle between the lines $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ is given by $\tan\theta = \left|\frac{2\sqrt{h^2 - ab}}{a + b}\right|$.

   $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, represents a pair of parallel lines, if $h^2 = ab$ and $af^2 = bg^2$ and the distance between the parallel lines is $\left|2\sqrt{g^2 - ac}\right|$.

   $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, represents a pair of perpendicular lines, if $a + b = 0$.

TRIGNOMETRY

Area of a sector of a circle = $\frac{1}{2}r^2\theta$.

Arc length, S = r θ.

$\sin\theta = \frac{opp}{hyp}$, $\cos\theta = \frac{adj}{hyp}$, $\tan\theta = \frac{opp}{adj}$, $\cot\theta = \frac{adj}{opp}$, $\sec\theta = \frac{hyp}{adj}$, $\text{cosec}\,\theta = \frac{hyp}{opp}$.

$\text{Sin}\theta = \frac{1}{\text{cosec}\theta}$ or $\text{cosec}\theta = \frac{1}{\sin\theta}$, $\cos\theta = \frac{1}{\sec\theta}$ or $\sec\theta = \frac{1}{\cos\theta}$,

$\tan\theta = \frac{1}{\cot\theta}$ or $\cot\theta = \frac{1}{\tan\theta}$, $\tan\theta = \frac{\sin\theta}{\cos\theta}$, $\cot\theta = \frac{\cos\theta}{\sin\theta}$.

$\sin^2\theta + \cos^2\theta = 1$; $\Rightarrow \sin^2\theta = 1 - \cos^2\theta$; $\cos^2\theta = 1 - \sin^2\theta$;

$\sec^2\theta - \tan^2\theta = 1$; $\Rightarrow \sec^2\theta = 1 + \tan^2\theta$; $\tan^2\theta = \sec^2\theta - 1$;

$\text{cosec}^2\theta - \cot^2\theta = 1$; $\Rightarrow \text{cosec}^2\theta = 1 + \cot^2\theta$; $\cot^2\theta = \text{cosec}^2\theta - 1$.

STANDARD ANGLES

	0^0 or 0	30^0 or $\frac{\pi}{6}$	45^0 or $\frac{\pi}{4}$	60^0 or $\frac{\pi}{3}$	90^0 or $\frac{\pi}{2}$	15^0 or $\frac{\pi}{12}$	75^0 or $\frac{5\pi}{12}$
Sin	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1	$\frac{\sqrt{3}-1}{2\sqrt{2}}$	$\frac{\sqrt{3}+1}{2\sqrt{2}}$
Cos	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0	$\frac{\sqrt{3}+1}{2\sqrt{2}}$	$\frac{\sqrt{3}-1}{2\sqrt{2}}$
Tan	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	∞	$\frac{\sqrt{3}-1}{\sqrt{3}+1}$	$\frac{\sqrt{3}+1}{\sqrt{3}-1}$
Cot	∞	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0	$\frac{\sqrt{3}+1}{\sqrt{3}-1}$	$\frac{\sqrt{3}-1}{\sqrt{3}+1}$
Sec	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	2	∞	$\frac{2\sqrt{2}}{\sqrt{3}+1}$	$\frac{2\sqrt{2}}{\sqrt{3}-1}$
Cosec	∞	2	$\sqrt{2}$	$\frac{2}{\sqrt{3}}$	1	$\frac{2\sqrt{2}}{\sqrt{3}-1}$	$\frac{2\sqrt{2}}{\sqrt{3}+1}$

ALLIED ANGLES

Trigonometric functions of angles which are in the 2nd, 3rd and 4th quadrants can be obtained as follows :

If the transformation begins at 90^0 or 270^0, the trigonometric functions changes

as sin $\leftrightarrow$ cos

tan $\leftrightarrow$ cot

sec $\leftrightarrow$ cosec

where as the transformation begins at 180^0 or 360^0, the same trigonometric functions will be retained, however the signs (+ or -) of the functions decides ASTC rule.

COMPOUND ANGLES

Sin(A+B)=sinAcosB+cosAsinB.

Sin(A-B)= sinAcosB-cosAsinB.

Cos(A+B)=cosAcosB-sinAsinB.

Cos(A-B)=cosAcosB+sinAsinB.

$$\tan(A+B)=\frac{\tan A+\tan B}{1-\tan A\tan B}$$

$$\tan(A-B)=\frac{\tan A-\tan B}{1+\tan A\tan B}$$

$$\tan\left(\frac{\pi}{4}+A\right)=\frac{1+\tan A}{1-\tan A}$$

$$\tan\left(\frac{\pi}{4}-A\right)=\frac{1-\tan A}{1+\tan A}$$

$$\tan(A+B+C)=\frac{\tan A+\tan B+\tan C-\tan A\tan B\tan C}{1-(\tan A\tan B+\tan B\tan C+\tan C\tan A)}$$

$\sin(A+B)\sin(A-B)=\sin^2 A-\sin^2 B=\cos^2 B-\cos^2 A$ $\cos(A+B)\cos(A-B)=\cos^2 A-\sin^2 B$

MULTIPLE ANGLES

1.sin 2A=2 sinA cosA. 2. $\sin 2A=\frac{2\tan A}{1+\tan^2 A}$.

3.cos 2A = $\cos^2 A-\sin^2 A$

$=1-2\sin^2 A$.

$=2\cos^2 A-1$

$=\frac{1-\tan^2 A}{1+\tan^2 A}$

4. $\tan 2A=\frac{2\tan A}{1-\tan^2 A}$, 5. $1+\cos 2A=2\cos^2 A$, 6. $\cos^2 A=\frac{1}{2}(1+\cos 2A)$.

7. $1-\cos 2A=2\sin^2 A$, 8. $\sin^2 A=\frac{1}{2}(1-\cos 2A)$, 9. $1+\sin 2A=(\sin A+\cos A)^2$,

10. $1-\sin 2A=(\cos A-\sin A)^2=(\sin A-\cos A)^2$, 11. $\cos 3A=4\cos^3 A-3\cos A$,

12. $\sin 3A=3\sin A-4\sin^3 A$, 13. $\tan 3A=\frac{3\tan A-\tan^3 A}{1-3\tan^2 A}$.

HALF ANGLE FORMULAE

1) $\sin\theta = 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}$. 2) $\sin\theta = \dfrac{2\tan\left(\frac{\theta}{2}\right)}{1+\tan^2\left(\frac{\theta}{2}\right)}$. 3) $\cos\theta = \cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}$.

4) $\cos\theta = 1 - 2\sin^2\frac{\theta}{2}$. 5) $\cos\theta = 2\cos^2\frac{\theta}{2} - 1$. 6) $\cos\theta = \dfrac{1-\tan^2\left(\frac{\theta}{2}\right)}{1+\tan^2\left(\frac{\theta}{2}\right)}$.

7) $\tan\theta = \dfrac{2\tan\left(\frac{\theta}{2}\right)}{1-\tan^2\left(\frac{\theta}{2}\right)}$. 8) $1+\cos\theta = 2\cos^2\frac{\theta}{2}$. 9) $1-\cos\theta = 2\sin^2\frac{\theta}{2}$.

PRODUCT TO SUM

$2 \sin A \cos B = \sin(A+B) + \sin(A-B)$.
$2 \cos A \sin B = \sin(A+B) - \sin(A-B)$.
$2 \cos A \cos B = \cos(A+B) + \cos(A-B)$.
$2 \sin A \sin B = \cos(A+B) - \cos(A-B)$.

SUM TO PRODUCT

$$\text{Sin } C + \sin D = 2\sin\left(\frac{C+D}{2}\right)\cos\left(\frac{C-D}{2}\right).$$

$$\text{Sin } C - \sin D = 2\cos\left(\frac{C+D}{2}\right)\sin\left(\frac{C-D}{2}\right).$$

$$\text{Cos } C + \cos D = 2\cos\left(\frac{C+D}{2}\right)\cos\left(\frac{C-D}{2}\right).$$

$$\text{Cos } C - \cos D = -2\sin\left(\frac{C+D}{2}\right)\sin\left(\frac{C-D}{2}\right)$$

OR

$$\text{Cos } C - \cos D = 2\sin\left(\frac{D+C}{2}\right)\sin\left(\frac{D-C}{2}\right)$$

PROPERTIES AND SOLUTIONS OF TRIANGLE

Sine Rule: $\dfrac{a}{\sin A}=\dfrac{b}{\sin B}=\dfrac{c}{\sin C}=2R$, where R is the circum radius of the triangle.

Cosine Rule: $a^2 = b^2 + c^2 - 2bc\cos A$ or $\cos A=\dfrac{b^2+c^2-a^2}{2bc}$,

$b^2 = a^2 + c^2 - 2ac\cos B$ or $\cos B=\dfrac{a^2+c^2-b^2}{2ac}$,

$c^2 = a^2 + b^2 - 2ab\cos C$ or $\cos C=\dfrac{a^2+b^2-c^2}{2ab}$.

Projection Rule: $a = b\cos C + c\cos B$

$b = c\cos A + a\cos C$

$c = a\cos B + b\cos A$

Tangents Rule:

$\tan\left(\dfrac{B-C}{2}\right)=\dfrac{b-c}{b+c}\cot\left(\dfrac{A}{2}\right)$,

$\tan\left(\dfrac{C-A}{2}\right)=\dfrac{c-a}{c+a}\cot\left(\dfrac{B}{2}\right)$,

$\tan\left(\dfrac{A-B}{2}\right)=\dfrac{a-b}{a+b}\cot\left(\dfrac{C}{2}\right)$.

Half angle formula:

$\sin\left(\dfrac{A}{2}\right)=\sqrt{\dfrac{(s-b)(s-c)}{bc}}$, $\cos\left(\dfrac{A}{2}\right)=\sqrt{\dfrac{s(s-a)}{bc}}$, $\tan\left(\dfrac{A}{2}\right)=\sqrt{\dfrac{(s-b)(s-c)}{s(s-a)}}$.

$\sin\left(\dfrac{B}{2}\right)=\sqrt{\dfrac{(s-a)(s-c)}{ac}}$, $\cos\left(\dfrac{B}{2}\right)=\sqrt{\dfrac{s(s-b)}{ac}}$, $\tan\left(\dfrac{B}{2}\right)=\sqrt{\dfrac{(s-a)(s-c)}{s(s-b)}}$.

$\sin\left(\dfrac{C}{2}\right)=\sqrt{\dfrac{(s-a)(s-b)}{ab}}$, $\cos\left(\dfrac{C}{2}\right)=\sqrt{\dfrac{s(s-c)}{ab}}$, $\tan\left(\dfrac{C}{2}\right)=\sqrt{\dfrac{(s-a)(s-b)}{s(s-c)}}$.

Area of triangle ABC $=\sqrt{s(s-a)(s-b)(s-c)}$,

Area of triangle ABC $=\dfrac{1}{2}bc\sin A=\dfrac{1}{2}ac\sin B=\dfrac{1}{2}ab\sin C$.

LIMITS

1. If $f(-x)=f(x)$, then $f(x)$ is called **Even Function**
2. If $f(-x)=-f(x)$, then $f(x)$ is called **Odd Function**
3. If P is the smallest $+ve$ real number such that if $f(x+P)=f(x)$, then $f(x)$ is called a **periodic function** with period P.
4. Right Hand Limit (RHL) = $\lim\limits_{x\to a+}(f(x))=\lim\limits_{h\to 0}(f(a+h))$

Left Hand Limit (LHL) = $\lim\limits_{x\to a-}(f(x))=\lim\limits_{h\to 0}(f(a-h))$

If RHL=LHL then $\lim\limits_{x\to a}(f(x))$ exists and

$\lim\limits_{x\to a}(f(x))$ = RHL=LHL

5. $\underset{n\to\infty}{Lt}\frac{1}{n^p}=0$, if $p>0$ and $\underset{n\to\infty}{Lt}n^p=\infty$ if $p>0$
6. $\underset{x\to 0}{Lt}\frac{\sin x}{x}=\underset{x\to 0}{Lt}\frac{\tan x}{x}(x \text{ in radians})=\underset{x\to 0}{Lt}\frac{x}{\sin x}=\underset{x\to 0}{Lt}\frac{x}{\tan x}=1$
7. $\underset{x\to 0}{Lt}\frac{\sin x^0}{x}=\underset{x\to 0}{Lt}\frac{\tan x^0}{x}=\frac{\pi}{180}$
8. $\underset{x\to\frac{\pi}{2}}{Lt}\frac{\sin x}{x}=\frac{2}{\pi}$
9. $\lim\limits_{x\to 0}\frac{\sin^{-1}x}{x}=1=\lim\limits_{x\to 0}\frac{\tan^{-1}x}{x}$
10. $\lim\limits_{x\to a}\frac{x^n-a^n}{x-a}=na^{n-1}$, where n is an **integer** or a **fraction**.
11. $\lim\limits_{x\to 0}\frac{a^x-1}{x}=\log a,\qquad \lim\limits_{x\to 0}\frac{e^x-1}{x}=\log e=1$
12. $\lim\limits_{x\to\infty}\left(1+\frac{1}{n}\right)^n=e,\qquad \lim\limits_{x\to 0}(1+n)^{\frac{1}{n}}=e$
13. $\lim\limits_{x\to a}[kf(x)]=k\lim\limits_{x\to a}f(x)$
14. $\lim\limits_{x\to a}[f(x)\pm g(x)]=\lim\limits_{x\to a}f(x)\pm\lim\limits_{x\to a}g(x)$
15. $\lim\limits_{x\to a}f(x).g(x)=\lim\limits_{x\to a}f(x).\lim\limits_{x\to a}g(x)$

$$\lim_{x\to a}\left(\frac{f(x)}{g(x)}\right)=\frac{\lim\limits_{x\to a}f(x)}{\lim\limits_{x\to a}g(x)}\ \textit{provided}\ \lim_{x\to a}g(x)\neq 0$$

16. A function $f(x)$ is said to be **continuous** at the point $x=a$ if

(i) $\lim\limits_{x\to a}f(x)$ exists (ii) $f(a)$ is defined (iii) $\lim\limits_{x\to a}f(x)=f(a)$

17. A function $f(x)$ is said to be **discontinuous or not continuous** at $x=a$ if

(i) $f(x)$ is not defined at $x=a$ (ii) $\lim\limits_{x\to a}f(x)$ does not exist at $x=a$

(iii) $\lim\limits_{x\to a+0}f(x)\neq\lim\limits_{x\to a-0}f(x)\neq f(a)$

18. If two functions $f(x)$ and $g(x)$ are continuous then $f(x)+g(x)$ is continuous