2025-2026

MATHS FORMULA SHEET

CLASS 11

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WARNING

Class XI – 2025 - 2026

INDEX

UNIT-1 (SETS AND FUNCTIONS)

CHAPTER-1

Sets

Set : A set is well defined collections of objects.

(i) Objects, elements and members of set are synonyms terms.

(ii) Sets are usually denoted by capital letters A, B, C, X, Y, Z etc.

(iii) The elements of a set are represented by small letters a, b, c, x, y, z etc.

Roaster or tabular form : Elements are listed, separated by commas and enclosed within curly brackets { } Example : {a, e, i, o, u} set of vowels.

Set builder form : All elements possess a single common property. Example : { x : x is a vowel in English alphabet}

Cardinal number : Number of elements of a Set A is called cardinal number and denoted by n(A).

Empty set : A set which does not contain any element is called the empty set or the null set or the void set.

Finite Set : A set which is empty or consists of a definite number of elements is called finite set.

Infinite Set : A set which is not empty & consists of a indefinite number of elements is called infinite set.

Equal Set : Two sets A and B are said to be equal if they have exactly the same elements and we write $A = B$. Otherwise, the sets are said to be unequal and we write $A \neq B$

Subset : A set A is said to be a subset of a set B if every element of A is also an element of B. $\boxed{A \subset B \text{ if } a \in A \Rightarrow a \in B}$

Proper subset : If $A \subset B$ and $A \neq B$, then A is called a proper subset of B and B is called superset of A.

Singleton set : If a set A has only one element, we call it singleton set.

Note : Subsets of set of real numbers $\boxed{N \subset Z \subset Q,\ Q \subset R,\ N \not\subset T}$

T = Irrational number

Intervals as subsets of R :

$(a, b) = \{x : a < x < b\}$ is an open interval, does not contain end points a & b.

$[a, b] = \{x : a \leq x \leq b\}$ is an closed interval, contain end points also.

$[a, b) = \{x : a \leq x < b\}$ is an open interval from a to b, including a but excluding b.

$(a, b] = \{x : a < x \leq b\}$ is an open interval from a to b, including b but excluding a.

Length of any interval : The number $(b-a)$ is called the length of any of the intervals (a, b), $[a, b]$, $[a, b)$ or $(a, b]$.

Power Set : The collection of all subsets of a set A is called the **power set** of A. denoted by $P(A)$.

Universal Set : A set that contains all sets in a given context is called **Universal set** denoted by U.

Union of Sets : The union of A and B is the set which consists of all the elements of B, the common elements being taken only once. The symbol '$\cup$' is used to denote the union. $\boxed{A \cup B = \{x : x \in A \text{ or } x \in B\}}$

Some Properties of the operation of union

(i) $\boxed{A \cup B = B \cup A}$ (Commutative law)

(ii) $\boxed{(A \cup B) \cup C = A \cup (B \cup C)}$ (Associative law)

(iii) $\boxed{A \cup \phi = A}$ (Law of identity element, ϕ is the identity of $\cup$)

(iv) $\boxed{A \cup A = A}$ (Idempotent law)

(v) $\boxed{U \cup A = U}$ (Law of U)

Intersection of Sets : The intersection of A and B is the set of all the elements which are common to both A and B. The symbol '$\cap$' is used to denote the intersection. $\boxed{A \cap B = \{x : x \in A \text{ and } x \in B\}}$

Some Properties of the operation of intersection

(i) $\boxed{A \cap B = B \cap A}$ (Commutative law)

(ii) $\boxed{(A \cap B) \cap C = A \cap (B \cap C)}$ (Associative law)

(iii) $\boxed{\phi \cap A = \phi, \; U \cap A = A}$ (Law of ϕ and U)

(iv) $\boxed{A \cap A = A}$ (Idempotent law)

(v) $\boxed{A \cap (B \cup C) = (A \cap B) \cup (A \cap C)}$ (Distributive law) i.e. $\cap$ distributes over $\cup$.

Difference of Sets : The difference of the two sets A and B in this order is the set of elements which belong to A but not to B.

$\boxed{A - B = \{x : x \in A \text{ and } x \notin B\}}$

Note : $\boxed{A - B \neq B - A}$

Complement of a Set : Let U be the universal set and A a subset of U. Then the complement of A is the set of all elements of U which are not the elements of A. denoted by A' $\boxed{A' = \{x : x \in U \text{ and } x \notin A\} \text{ obviously } A' = U - A}$

Some properties of Complement Sets

1. **Complement laws** : (i) $\boxed{A \cup A' = U}$ (ii) $\boxed{A \cap A' = \phi}$

2. De Morgan's law : (i) $(A \cup B)' = A' \cap B'$ (ii) $(A \cap B)' = A' \cup B'$

3. Law of double complementation : $(A')' = A$

4. Laws of empty set and universal set : $\phi' = U$ and $U' = \phi$

Practical Problems on Union and intersection of two sets :

(i) $\boxed{n(A \cup B) = n(A) + n(B)}$

(ii) $\boxed{n(A \cup B) = n(A) + n(B) - n(A \cap B)}$

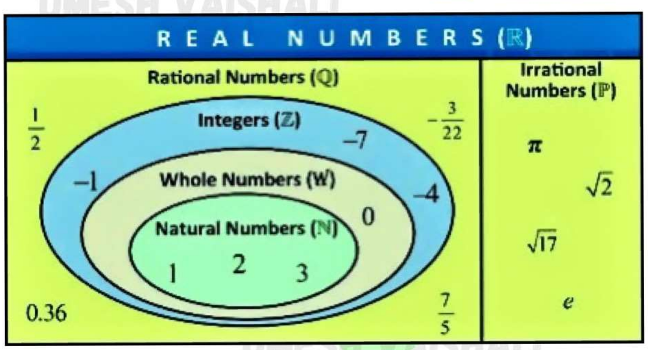
(iii) If A, B and C are finite sets, then

$$\boxed{n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(A \cap C) + n(A \cap B \cap C)}$$

Note : If A is a subset of the universal set U, then its complement A' is also a subset of U.

Important Note :

$=$	equal to	$<$	less then
$\neq$	Not equal to	$\leq$	less then equal to
$\subset$	subset	$>$	greater than
$\not\subset$	not a subset	$\geq$	greater than equal to
$\Rightarrow$	implies	$\supset$	Superset
$\Leftrightarrow$	if and only if	$\not\supset$	Not superset
$\in$	belongs to OR contains in	$\cup$	Union
$\forall$	for all	$\cap$	Intersection
$:$	such that		



N : the set of the all natural numbers.
Z : the set of the all integers.
Q : the set of the all rational numbers.
R : the set of the all real numbers.
Z^+ : the set of the all positive integers.
Q^+ : the set of the all positive rational numbers.
R^+ : the set of the all positive real numbers.

CHAPTER-2

Relations & Functions

Cartesian product : Given two non-empty sets P and Q. The cartesian Product $P \times Q$ is the set of all ordered pair of elements from P and Q i.e.,

$\boxed{P \times Q = \{(p,q) : p \in P,\ q \in Q\}}$ If either P or Q is the null set, then $P \times Q$ will also be empty set, i.e. $P \times Q = \phi$ If $A = \{a_1, a_2\}$ and $B = \{b_1, b_2, b_3, b_4\}$ then $A \times B = \{(a_1, b_1), (a_1, b_2), (a_1, a_3), (a_1 b_4), (a_2 b_1), (a_2 b_2), (a_2 b_3), (a_2 b_4)\}$

Note : (i) Two ordered pairs are equal, if and only if the coorresponding first elements are equal and the second elements are also equal.

(ii) If $n(A) = p$ and $n(B) = q$, then $n(A \times B) = pq$.

(iii) If A and B are non-empty sets and either A or B is an infinite set then, $A \times B$ is also a infinite set.

(iv) $A \times A \times A = \{(a,b,c) : a, b, c \in A\}$. Here (a,b,c) is called an ordered triplet.

Relations : A Relation R from a non-empty set A to a non-empty set B is a subset of the cartesian product $A \times B$. The subset is derived by describing a relationship between the first element and the second element of the ordered pairs in $A \times B$. The second element is called the image of the first element.

Domain : The set of all first elements of the ordered pairs in a relation R from a set A to a set B is called the domain of the relation R.

Range : The set of all second elements in a relation R from a Set A to Set B is called the range of the relation R.

Codomain : The whole set B is called the codomain of the relation R.

$\boxed{\text{range} \subseteq \text{codomain.}}$

Note : A Relation R from A to A is also stated as a relation on A.

Note : If $n(A) = p$ and $n(B) = q$,

then, $n(A \times B) = pq$

the total no. of relation is $= 2^{pq}$

function : A relation f from a Set A to a Set B is said to be a function if every element of Set A has one and only one image in Set B. If f is a function from A to B and $(a,b) \in f$, then b is called the image of a under f and a is called the preimage of b under f. The function f from A to B is denoted by $f : A \rightarrow B$

Real valued function : A function which has either R or one of its subsets as its range is called a real valued function

Some functions :

1. **Identity function** : Let R be the set of real numbers. Define the real valued function $f : R \rightarrow R$ by $y = f(x) = x$ for each $x \in R$. Such a function is called the identity function.

2. **Constant function** : Define the function $f : R \rightarrow R$ by $y = f(x) = c$, $x \in R$ where c is a constant and each $x \in R$. Here domain of f is R and its range is $\{c\}$.

3. **Polynomial function** : A function $f : R \rightarrow R$ is said to be polynomial function if for each x in R, $y = f(x) = a_0 + a_1 x + a_2 x^2 + \ldots + a_n x^n$, where n is a non-negative integer and $a_0, a_1, a_2, \ldots, a_n \in R$.

4. **Rotational function** : Rotational functions are function of the type $\frac{f(x)}{g(x)}$, where f(x) and g(x) are polynomial functions of x defined in a domain, where $g(x) \neq 0$.

5. **The modulus function** : The function $f : R \rightarrow R$ defined by $f(x) = |x|$ for each $x \in R$ is called modulus function

6. **Signum function** : The function $f : R \rightarrow R$ defined by $f(x) = \begin{cases} 1, & \text{if } x > 0 \\ 0, & \text{if } x = 0 \\ -1, & \text{if } x < 0 \end{cases}$ is called the signum function

7. **Greatest integer function** : The function $f : R \rightarrow R$ defined by $f(x) = [x]$, $x \in R$ assumes the value of the greatest integer, less than or equal to x. Such a function is called the greatest integer function.

Algebra of real functions : Let $f : X \rightarrow R$ & $g : X \rightarrow R$

Note : $A \times \phi = \phi$

1. **Addition of two real functions** : $\boxed{(f+g)(x) = f(x) + g(x)}$ for all $x \in X$

2. **Subtraction of a real function from another** : $\boxed{(f-g)(x) = f(x) - g(x)}$ for all $x \in X$

3. **Multiplication by a scalar** : $\boxed{(\alpha f)(x) = \alpha f(x)}$, $x \in X$

4. **Multiplication of two real functions** : $\boxed{(fg)(x) = f(x)\, g(x)}$ for all $x \in X$ (pointwise multiplication)

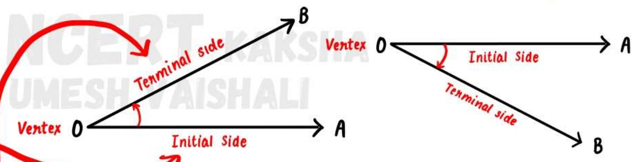
5. **Quotient of two real functions** : $\boxed{\left[\frac{f}{g}\right](x) = \frac{f(x)}{g(x)}}$, provided $g(x) \neq 0$, $x \in X$.

CHAPTER-3

UNIT-I (SETS AND FUNCTIONS)

Trigonometric Functions

- Angle is a measure of rotation of a given ray about its initial point.
- The original ray is called the initial side. The final position of the ray after rotation is called terminal side.



(Positive angle) Rotation is anticlockwise

(Negative angle) Rotation is clockwise

- $1^\circ = 60'$
- $1' = 60''$

1° (one degree) / $1'$ (one minute) / $1''$ (one second)

- $\boxed{\theta = \dfrac{l}{r}}$ θ = angle, l = an arc of length, r = radius of a circle
- Value of $\pi = \dfrac{22}{7} = 3.14$
- $1 \text{ radian} = \dfrac{180^\circ}{\pi}$
- 2π radian $= 360^\circ$
- π radian $= 180^\circ$
- $1^\circ = \dfrac{\pi}{180}$ radian

$$\text{Radian measure} = \frac{\pi}{180} \times \text{Degree measure}$$

$$\text{Degree measure} = \frac{180}{\pi} \times \text{Radian measure}$$

$$\sin^2 x + \cos^2 x = 1$$

$$1 + \tan^2 x = \sec^2 x$$

$$1 + \cot^2 x = \operatorname{cosec}^2 x$$

$$\sin(-x) = -\sin x \qquad \cos(-x) = \cos x$$

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$
$$\sin(x-y) = \sin x \cos y - \cos x \sin y$$
$$\cos(x+y) = \cos x \cos y - \sin x \sin y$$
$$\cos(x-y) = \cos x \cos y + \sin x \sin y$$

$$\sin 2x = 2\sin x \cos x = \frac{2\tan x}{1+\tan^2 x}$$

$$\cos 2x = \cos^2 x - \sin^2 x \text{ OR } \frac{1-\tan^2 x}{1+\tan^2 x}$$
$$= 2\cos^2 x - 1$$
$$= 1 - 2\sin^2 x$$

$$\tan 2x = \frac{2\tan x}{1-\tan^2 x}$$

$$\cos\left(\frac{\pi}{2}-x\right) = \sin x \qquad \cos\left(\frac{\pi}{2}+x\right) = -\sin x$$

$$\sin\left(\frac{\pi}{2}-x\right) = \cos x \qquad \sin\left(\frac{\pi}{2}+x\right) = \cos x$$

$$\sin 3x = 3\sin x - 4\sin^3 x$$
$$\cos 3x = 4\cos^3 x - 3\cos x$$
$$\tan 3x = \frac{3\tan x - \tan^3 x}{1 - 3\tan^2 x}$$

$$\cos(\pi - x) = -\cos x \qquad \sin(\pi - x) = \sin x$$
$$\cos(\pi + x) = -\cos x \qquad \sin(\pi + x) = -\sin x$$
$$\cos(2\pi - x) = \cos x \qquad \sin(2\pi - x) = -\sin x$$

$$\cos x + \cos y = 2\cos\frac{x+y}{2}\cos\frac{x-y}{2}$$
$$\cos x - \cos y = -2\sin\frac{x+y}{2}\sin\frac{x-y}{2}$$
$$\sin x + \sin y = 2\sin\frac{x+y}{2}\cos\frac{x-y}{2}$$
$$\sin x - \sin y = 2\cos\frac{x+y}{2}\sin\frac{x-y}{2}$$

$$\tan(x+y) = \frac{\tan x + \tan y}{1 - \tan x \tan y} \qquad \tan(x-y) = \frac{\tan x - \tan y}{1 + \tan x \tan y}$$

$$\cot(x+y) = \frac{\cot x \cot y - 1}{\cot y + \cot x} \qquad \cot(x-y) = \frac{\cot x \cot y + 1}{\cot y - \cot x}$$

- $\sin x = 0$ gives $\boxed{x = n\pi}$, where $n \in Z$
- $\cos x = 0$ gives $\boxed{x = (2n+1)\frac{\pi}{2}}$, where $n \in Z$

$$2\cos x \cos y = \cos(x+y) + \cos(x-y)$$
$$-2\sin x \sin y = \cos(x+y) - \cos(x-y)$$
$$2\sin x \cos y = \sin(x+y) + \sin(x-y)$$
$$2\cos x \sin y = \sin(x+y) - \sin(x-y)$$

- $\sin x = \sin y$ implies $\boxed{x = n\pi + (-1)^n y}$, where $n \in Z$
- $\cos x = \cos y$ implies $\boxed{x = 2n\pi \pm y}$, where $n \in Z$
- $\tan x = \tan y$ implies $\boxed{x = n\pi + y}$, where $n \in Z$

Quadrantal angles : All angles which are integral multiples of $\frac{\pi}{2}$ are called quadrantal angles.

$\sin x = 0$ implies $x = n\pi$, where n is any integer.

$\cos x = 0$ implies $x = (2n+1)\frac{\pi}{2}$, where n is any integer.

$\operatorname{cosec} x = \frac{1}{\sin x}$, $x \neq n\pi$, where n is any integer.

$\sec x = \frac{1}{\cos x}$, $x \neq (2n+1)\frac{\pi}{2}$, where n is any integer.

$\tan x = \frac{\sin x}{\cos x}$, $x \neq (2n+1)\frac{\pi}{2}$, where n is any integer.

$\cot x = \frac{\cos x}{\sin x}$, $x \neq n\pi$, where n is any integer.

Trigonometric Equations : Equations involving trigonometric functions of a variable are called trigonometric Equations.

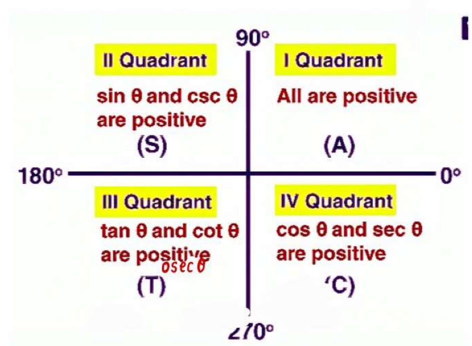
Principal solutions : The solutions of a trigometric equation for which $0 \le x \le 2\pi$ are called principal solutions.

General solution : The expression involving integer 'n' which give all solutions of atrigonometric equation is called the general function.

Trigonometry Table :

θ	0°	30°	45°	60°	90°	180°	270°	360°
sin θ	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1	0	-1	0
cos θ	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0	-1	0	1
tan θ	0	$\frac{1}{\sqrt{3}}$	1	√3	Not defined	0	Not defined	0
cosec θ	Not defined	2	√2	$\frac{2}{\sqrt{3}}$	1	Not defined	-1	Not defined
sec θ	1	$\frac{2}{\sqrt{3}}$	√2	2	Not defined	-1	Not defined	1
cot θ	Not defined	√3	1	$\frac{1}{\sqrt{3}}$	0	Not defined	0	Not defined

Trigonometric functions in different quadrants :



CHAPTER - 4

UNIT-2 (ALGEBRA)

Complex Numbers and Quadratic Equations

Complex Numbers (z) (real numbers + imaginary number) : General form $\boxed{z = a + ib}$

(real part) Re z
(imaginary part) Im z

a, b = real numbers

Note : Two complex numbers $z = a + ib$ and $z = c + id$ are equal if $a = c$ and $b = d$

Algebra of Complex numbers :

1. Addition of two complex numbers :

(a) The closure law : $\boxed{z_1 + z_2}$ z_1, z_2 = two complex no.

(b) The commutative law : $\boxed{z_1 + z_2 = z_2 + z_1}$

(c) The associative law : $\boxed{(z_1 + z_2) + z_3 = z_1 + (z_2 + z_3)}$

(d) The existence of additive identity : $0 + i0$ denoted as 0 (zero complex no.) $\boxed{z + 0 = z}$ additive identity

(e) The existence of additive inverse : $-a + i(-b)$ denoted as $-z$ (negative of z) $\boxed{z + (-z) = 0}$ additive inverse

2. Difference of two complex numbers : $\boxed{z_1 - z_2 = z_1 + (-z_2)}$

3. Multiplication of two complex numbers : Let $z_1 = a + ib$ and $z_2 = c + id$, then, the product $z_1 z_2$ is $z_1 z_2 = (ac - bd) + i(ad + bc)$

(a) The closure law : $\boxed{z_1 z_2}$ z_1, z_2 = two complex no.

(b) The commutative law : $\boxed{z_1 z_2 = z_2 z_1}$

(c) The associative law : $\boxed{(z_1 z_2) z_3 = z_1 (z_2 z_3)}$

(d) The existence of multiplicative identity : $1 + i0$ denoted as 1 $\boxed{z \cdot 1 = z}$ multiplicative identity

(e) The existence of multiplicative inverse : $\frac{a}{a^2+b^2} + i\frac{-b}{a^2+b^2}$ denoted as $\frac{1}{z}$ OR z^{-1}

$\boxed{z \cdot \frac{1}{z} = 1}$ multiplicative inverse

(f) The distribution law : (a) $\boxed{z_1 (z_2 + z_3) = z_1 z_2 + z_1 z_3}$

(b) $\boxed{(z_1 + z_2) z_3 = z_1 z_3 + z_2 z_3}$ z_1, z_2, z_3 = three complex no.

4. Division of two complex numbers : $\boxed{\frac{z_1}{z_2} = z_1 \frac{1}{z_2}}$ $z_2 \neq 0$

Power of i : $\boxed{i = \sqrt{-1}}$ $\boxed{i^2 = -1}$ $\boxed{i^3 = -i}$ $\boxed{i^4 = 1}$ $\boxed{i^5 = i}$ $\boxed{i^6 = -1}$

Note : Any integer k, $i^{4k} = 1$, $i^{4k+1} = i$, $i^{4k+2} = -1$, $i^{4k+3} = -i$

Identities

$$\boxed{(z_1 + z_2)^2 = z_1^2 + z_2^2 + 2z_1z_2}$$

$$\boxed{(z_1 - z_2)^2 = z_1^2 + z_2^2 - 2z_1z_2}$$

$$\boxed{(z_1 + z_2)^3 = z_1^3 + 3z_1^2z_2 + 3z_1z_2^2 + z_2^3}$$

$$\boxed{(z_1 - z_2)^3 = z_1^3 - 3z_1^2z_2 + 3z_1z_2^2 - z_2^3}$$

$$\boxed{z_1^2 - z_2^2 = (z_1 + z_2)(z_1 - z_2)}$$

Modulus : Let $z = a + ib$

Modulus of z $\boxed{|z| = \sqrt{a^2 + b^2}}$

Conjugate : Let $z = a + ib$

conjugate of z $\boxed{\bar{z} = a - ib}$

Note :

(a) $\boxed{|z_1 z_2| = |z_1||z_2|}$

(b) $\boxed{\left|\frac{z_1}{z_2}\right| = \frac{|z_1|}{|z_2|}}$

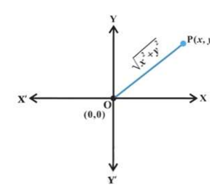
(c) $\boxed{\overline{\left(\frac{z_1}{z_2}\right)} = \frac{\overline{z_1}}{\overline{z_2}}}$ $z_2 \neq 0$

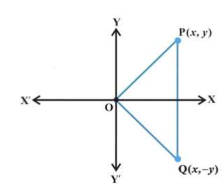
(d) $\boxed{\overline{z_1 z_2} = \overline{z_1}\,\overline{z_2}}$

(e) $\boxed{\overline{z_1 \pm z_2} = \overline{z_1} \pm \overline{z_2}}$

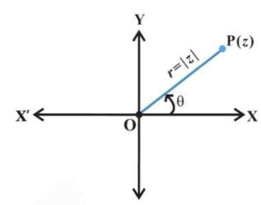
(f) $\boxed{z\bar{z} = |z|^2}$

Argand Plane : The Plane having a complex number assigned to each of its point is called the complex plane on the argand plane $x + iy = \sqrt{x^2 + y^2}$ is the distance between the point $P(x, y)$ and the origin $O(0,0)$ The x-axis and y-axis in the argand plane, respectivelly, the real axis and the imaginary axis. The point $(x, -y)$ is the mirror image of the point (x, y) on the real axis.





Polar form of the complex no. : Let the point P represent the non-zero complex no. $z = x + iy$

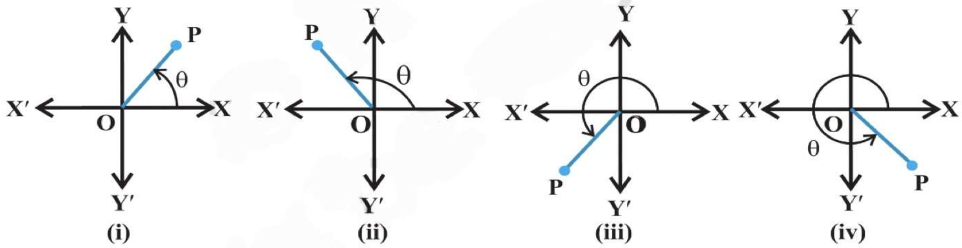


$z = r(\cos\theta + i\sin\theta)$ where $x = r\cos\theta$, $y = r\sin\theta$

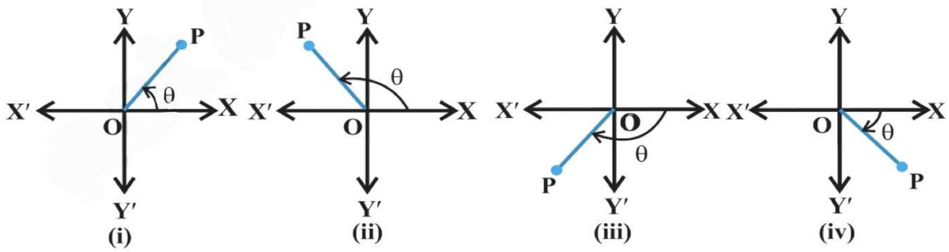
$r = \sqrt{x^2 + y^2} = |z|$ (modulus of z)

θ = arguement of z (arg z)

For any complex no. $z \neq 0$, there coorresponds only one value of θ in $0 \leq \theta < 2\pi$ The value of θ, such that $-\pi < \theta \leq \pi$ is called the principal arguement of z



$(0 \le \theta < 2\pi)$



$(-\pi < \theta \le \pi)$

Quadratic Equations $ax^2 + bx + c = 0$

where $a, b, c \in R$, $a \neq 0$, $b^2 - 4ac < 0$

then, the solution of the quadratic equation is ,

$$\boxed{x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-b \pm \sqrt{4ac - b^2}\, i}{2a}}$$

Note : A polynomial equation has at least one root.

Note : A polynomial equation of degree n has n roots.

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UNIT-2 (ALGEBRA)

CHAPTER-5 Linear Inequalities

Inequality : Two real numbers on two algebraic expressions related by the symbol '<', '>', '≤' or '≥' from an inequality

Types of inequalities :

1. **Numerical inequalities** : $3 < 5$, $7 > 5$
2. **literal inequalities** : $x < 5$, $x \geq 3$
3. **double inequalities** : $2 < y \leq 4$
4. **strict inequalities** : $ax + by < 0$, $ax + by > 0$
5. **slack inequalities** : $ax + by \geq c$
6. **linear inequalities** : $ax + b \leq 0$
7. **quadratic inequalities** : $ax^2 + bx + c \leq 0$

Solution Set : The values of x which makes an inequality a true statement are called solutions of inequality and the set of solution is called solution set.

While solving linear equations, we followed the following rules :

Rule 1 : Equal numbers may be added (or subtracted from) both sides of an equation.

Rule 2 : Both sides of an equation may be multiplied (or divided) by the same non-zero number.

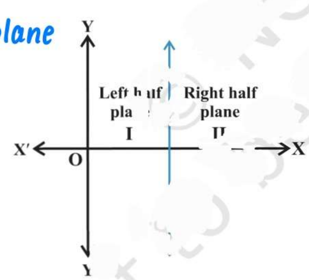
We state following rules for solving an inequality :

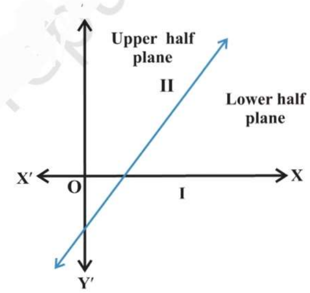
Rule 1 : Equal numbers may be added to (or subtracted from) both sides of an inequality without affecting the sign of inequality.

Rule 2 : Both sides of an inequality can be multiplied (or divided) by the same positive number. But when both sides are multiplied or divided by a negative number, then the sign of inequality is reversed.

Graphical Solution of Linear inequalities in Two variables :

Graph of inequalities will be one of the half plane (called solution region) and represented by shading in the corresponding half plane.





Note : **1.** The region containing all the solutions of an inequality is called the solution region.

2. In order to identify the half plane represented by an inequality, it is just sufficient to take any point (a, b) (not online) and check whether it satisfies the inequality or not. If it satisfies, then the inequality represents the half plane and shade the region which contains the point, otherwise, the inequality represents that half plane which does not contain the point within it. For convenience the point $(0, 0)$ is preferred.

3. If an inequality is of the type $ax + by \geq c$ or $ax + by \leq c$, then the points on the line $ax + by = c$ are also included in the solution region. So draw a dark line in the solution region.

4. If an inequality is of the form $ax + by < c$ or $ax + by < c$, then the points on the line $ax + by = c$ are not to be included in the solution region. So draw a broken or dotted line in the solution region.

Note : **1.** To represent $x < a$ (or $x > a$) on a number line, put a circle on the number a and dark line to the left (or right) of the number a.

2. To represent $x \leq a$ (or $x \geq a$) on a number line, put a dark circle on the number a and dark line to the left (or right) of the number x.

3. The solution region of a system of inequalities in the region which satisfies all the given inequalities in the system simultaneously.

your only limit is your Mind

Permutations and Combinations

Fundamental principle of counting : If an event can occur in m different ways, following which another event can occur in n different ways, then the total number of occurence of the events in the given order is $m \times n$.

Permutations : The number of permutations of n different things taken r at a time, where repetition is not allowed, is denoted by ${}^nP_r$. $\boxed{{}^nP_r = \frac{n!}{(n-r)!}}$ where $0 \le r \le n$

$\boxed{n! = 1 \times 2 \times 3 \times \ldots \times n}$

$\boxed{n! = n \times (n-1)!}$ Factorial Notation (!) Ex: $3! = 1 \times 2 \times 3 = 6$

Theorem 1 : The number of permutations of n different things, taken r at a time, where $0 < r \le n$ and the objects do not repeat is $n(n-1)(n-2)\ldots(n-r+1)$ which is denoted by ${}^nP_r$.

Theorem 2 : The number of permutations of n different things, taken r at a time, where repetition is allowed, is n^r.

Theorem 3 : The number of permutations of n objects, where p objects are of the same kind and rest are all different $= \frac{n!}{p!}$

Theorem 4 : The number of permutations of n objects taken all at a time, where p_1 objects are of first kind, p_2 objects are of the second kind, ..., p_k objects are of the k^{th} kind and rest, if any, are all different is $\frac{n!}{p_1!\, p_2! \ldots p_k!}$

Combinations : The number of combinations of n different things taken r at a time, denoted by ${}^nC_r$ $\boxed{{}^nC_r = \frac{n!}{r!(n-r)!} ;\ 0 \le r \le n}$

Theorem 5 : $\boxed{{}^nP_r = {}^nC_r\, r! ;\ 0 < r \le n}$

Theorem 6 : $\boxed{{}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r}$

Note : 1. From above $\frac{n!}{(n-r)!} = {}^nC_r \times r!$, i.e. ${}^nC_r = \frac{n!}{r!(n-r)!}$

In particular, if $r = n$, $^nC_n = \dfrac{n!}{n!\,0!} = 1$

2. We define $^nC_0 = 1$, i.e., the number of combinations of n different things taken nothing at all is considered to be 1. Counting combinations is merely counting the no. of ways in which some or all objects at a time are selected. Selecting nothing at all is the same as leaving behind all the objects and we know that there is only one way of doing so. This way we define $^nC_0 = 1$.

3. As $\dfrac{n!}{0!\,(n-0)!} = 1 = {^nC_0}$, the formula $^nC_r = \dfrac{n!}{r!\,(n-r)!}$ is applicable for $r = 0$ also.

Hence $^nC_r = \dfrac{n!}{r!\,(n-r)!}$; $0 \le r \le n$.

4. $^nC_{n-r} = \dfrac{n!}{(n-r)!\,(n-(n-r))!} = \dfrac{n!}{(n-r)!\,r!} = {^nC_r}$ i.e., selecting r objects out of n objects is same as rejecting (n-r) objects.

5. $^nC_a \Rightarrow {^nC_a} \Rightarrow a = b$ or $a = n - b$, i.e., $n = a + b$

Believe in yourself and ANYTHING is possible.

Umesh Bhaiya ❤

Always with you

Vaishali Didi ❤

Always with you

CHAPTER-7

Binomial Theorem

Note : $(a+b)^0 = 1$

$(a+b)^1 = a+b$

$(a+b)^2 = a^2 + 2ab + b^2$

$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$

$(a+b)^4 = (a+b)^3(a+b) = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$

Pascal's Triangle : The cofficients of the expansion are arranged in an array. This array is called Pascal's Triangle.

The expansion of a binomial for any positive integral n

$$\boxed{(a+b)^n = {}^nC_0\, a^n + {}^nC_1\, a^{n-1} b + {}^nC_2\, a^{n-2} b^2 + \ldots + {}^nC_{n-1}\, a . b^{n-1} + {}^nC_n\, b^n}$$

Observations :

1. The notation $\sum_{k=0}^{n} {}^nC_k\, a^{n-k} b^k$ stands for ${}^nC_0\, a^n b^0 + {}^nC_1\, a^{n-1} b^1 + {}^nC_2\, a^{n-2} b^2 + \ldots\ldots + {}^nC_n\, a^{n-n} b^n$, where $b^0 = 1 = a^{n-n}$ Hence the theorem can also be stated as $(a+b)^n = \sum_{k=0}^{n} {}^nC_k\, a^{n-k} b^k$.

2. The cofficients ${}^nC_r$ occuring in the binomial theorem are known as binomial cofficients.

3. There are $(n+1)$ terms in the expansion of $(a+b)^n$, i.e. one more than the index.

4. In the successive terms of the expansion the index of a goes on decreasing by unity. It is n in the first term, $(n-1)$ in the second term, and so on ending with zero in the last term. At the same time the index of b increases by unity, starting with zero in the first term, 1 in the second and so on ending with n in the last term.

5. In the expansion of $(a+b)^n$, the sum of the indices of a and b is $n+0 = n$ in the first term, $(n-1)+1 = n$ in the second term and so on $0+n = n$ in the last term. Thus it can be seen that the sum of the indices of a and b in every term of the expansion.

Some special cases

- $a = x$ and $b = -y$: $\boxed{(x-y)^n = {}^nC_0 x^n - {}^nC_1 x^{n-1} y + {}^nC_2 x^{n-2} y^2 - \ldots + (-1)^n\, {}^nC_n y^n}$
- $a = 1$ and $b = x$: $\boxed{(1+x)^n = {}^nC_0 + {}^nC_1 x + {}^nC_2 x^2 + {}^nC_3 x^3 + \ldots + {}^nC_n x^n}$
- $a = 1$ and $b = -x$: $\boxed{(1-x)^n = {}^nC_0 - {}^nC_1 x + {}^nC_2 x^2 - \ldots + (-1)^n\, {}^nC_n x^n}$

General term

: In General term of an expansion $(a+b)^n$ is

$$\boxed{T_{r+1} = {}^nC_r\, a^{n-r} . b^r} \quad [(r+1)^{th} \text{ term}]$$

Middle terms

(i) If n is even, then the number of terms in the expansion will be $n+1$. Since n is even so $(n+1)$ is odd. Therefore, the middle term is $\left[\frac{n+1+1}{2}\right]^{th}$, i.e. $\left[\frac{n}{2}+1\right]^{th}$ term.

(ii) If n is odd, then $(n+1)$ is even, so there will be two middle terms in the expansion, namely, $\left[\frac{n+1}{2}\right]^{th}$ term and $\left[\frac{n+1}{2}+1\right]^{th}$ term.

(iii) In the expansion of $\left[x + \frac{1}{x}\right]^{2n}$, where $x \neq 0$, the middle term is $\left[\frac{2n+1+1}{2}\right]^{th}$ i.e. $(n+1)^{th}$ term, $2n$ is even. It is given by ${}^{2n}C_n\, x^n \left[\frac{1}{x}\right]^n = {}^{2n}C_n$ (constant).

UNIT-2 (ALGEBRA)

CHAPTER-8

Sequence and Series

Sequence : A sequence can be regarded as a function whose domain is the set of natural numbers or some subset of it of the type $\{1, 2, 3 \ldots k\}$. Sometimes, we use the functional notation $a(n)$ for a_n.

Series : Let $a_1, a_2, a_3 \ldots\ldots, a_n$ be a given sequence. Then, the expression $a_1 + a_2 + a_3 + \ldots + a_n + \ldots$ is called the series associated with the given sequence.

$$\boxed{a_1 + a_2 + a_3 + \ldots + a_n = \sum_{k=1}^{n} a_k}$$

Arithmetic progression : $a,\ a+d,\ a+2d \ldots\ldots$

- n^{th} term (General term) $\boxed{a_n = a + (n-1)d}$ $\boxed{l = a + (n-1)d}$
- The sum of n terms $\boxed{S_n = \frac{n}{2}[2a + (n-1)d]}$
- Sum of A.P. when first and last term is given, $\boxed{S_n = \frac{n}{2}[a + l]}$

a = first term
l = last term
d = common difference
n = the no. of terms
S_n = the sum of n terms

Arithmetic Mean (A.M.) $\boxed{A = \frac{a+b}{2}}$

a and b = two numbers
A = Arithmetic Mean

Geometric Progression (G.P.) $a,\ ar,\ ar^2,\ ar^3, \ldots\ldots$

- General term of G.P. $\boxed{a_n = ar^{n-1}}$ r = common ratio
- Sum of n terms of G.P. $\boxed{S_n = a + ar + ar^2 + ar^3 + \ldots + ar^{n-1}}$

Case I If $r = 1$ $\boxed{S_n = na}$

Case II If $r \neq 1$ $\boxed{S_n = \frac{a(1-r^n)}{1-r}}$ $\rightarrow r<1$ OR $\boxed{S_n = \frac{a(r^n - 1)}{r-1}}$ $\rightarrow r>1$

Relationship between A.M and G.M. $\boxed{A - G = \frac{(\sqrt{a} - \sqrt{b})^2}{2} \geq 0}$; $a, b > 0$

Sum of first n natural numbers $S_n = 1 + 2 + 3 + \ldots + n$; $\boxed{S_n = \frac{n(n+1)}{2}}$

Sum of squares of the first n natural numbers

$S_n = 1^2 + 2^2 + 3^2 + \ldots + n^2$; $\boxed{S_n = \frac{n(n+1)(2n+1)}{6}}$

Sum of cubes of the first n natural numbers

$S_n = 1^3 + 2^3 + 3^3 + \ldots + n^3$; $\boxed{S_n = \frac{[n(n+1)]^2}{4}}$

Geometric Mean (G.M.)

$\boxed{G = \sqrt{ab}}$; $a, b > 0$

UNIT-3 (COORDINATE GEOMETRY)

CHAPTER-9

Straight Lines

- Distance between the points $P(x_1, y_1)$ and $Q(x_2, y_2)$ is

$$\boxed{PQ = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}}$$

- Coordinates of a point dividing the line segment joining the points (x_1, y_1) and (x_2, y_2) internally in the ratio $m:n$ are

$$\left[\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n}\right]$$

- In particular, If $m = n$, the coordinates of the mid point of the line segment joining the points (x_1, y_1) and (x_2, y_2) are

$$\left[\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right]$$

- Area of triangle $\boxed{\frac{1}{2}[x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)]}$

vertices are (x_1, y_1), (x_2, y_2) and (x_3, y_3)

Note: If the area of the triangle ABC is zero, then three points A, B and C lie on a line, i.e., they are collinear.

- Slope of a line $\boxed{m = \tan\theta}$ $(\theta \neq 90^\circ)$

Note: The slope of x-axis is zero and slope of y-axis is not defined.

- Slope of the line through the points (x_1, y_1) and (x_2, y_2) $\boxed{m = \frac{y_2 - y_1}{x_2 - x_1}}$

- If the line l_1 is parallel to l_2 $\boxed{m_1 = m_2}$ $\boxed{\tan\alpha = \tan\beta}$

- If the line l_1 and l_2 are perpendicular $\boxed{m_2 = -\frac{1}{m_1}}$ OR $\boxed{m_1 m_2 = -1}$

$$\boxed{\begin{aligned}\tan\beta &= \tan(\alpha + 90^\circ)\\ &= -\cot\alpha = -\frac{1}{\tan\alpha}\end{aligned}}$$

Acute angle θ between two lines with slopes m_1 and m_2

$$\boxed{\tan\theta = \left|\frac{m_2 - m_1}{1 + m_1 m_2}\right|, \quad 1 + m_1 m_2 \neq 0}$$

Collinearity of three points

Three points are collinear if and only if $\boxed{\text{slope of } AB = \text{slope of } BC}$

Point - slope form

$$\boxed{y - y_1 = m(x - x_1)}$$

Two - point form

$$\boxed{y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)}$$

Slope - intercept form

Case I $\boxed{y = mx + c}$

slope m and y - intercept c

Case II $\boxed{y = m(x - d)}$

slope m and x - intercept d

Intercept form

$$\boxed{\frac{x}{a} + \frac{y}{b} = 1}$$

x - intercept a and y - intercept b

Normal form

$$\boxed{x\cos\omega + y\sin\omega = p}$$

Normal distance from the origin.

Distance of a point from a line

$$\boxed{d = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}}}$$

$Ax + By + c = 0$ from a point (x_1, y_1)

Distance between two parallel lines

$$\boxed{d = \frac{|C_1 - C_2|}{\sqrt{A^2 + B^2}}}$$

two parallel lines

$Ax + By + C_1 = 0$ and

$Ax + By + C_2 = 0$

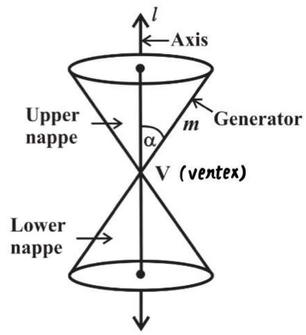
UNIT-3 (COORDINATE GEOMETRY)

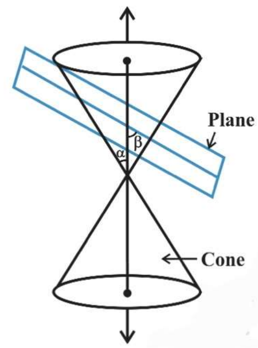
CHAPTER-10

Conic Sections

Sections of a cone :

The intersection of a plane with a cone, the section so obtained is called a conic section.





Circle, ellipse, parabola and hyperbola : When the plane cuts nappe of the cone, we have the following situations :

(a) When $\beta = 90^\circ$, the section is a circle.

(b) When $\alpha < \beta < 90^\circ$, the section is an ellipse.

(c) When $\beta = \alpha$; the section is a parabola.

(d) When $0 \le \beta < \alpha$; the plane cuts through both the nappes and the curves of intersection is a hyperbola

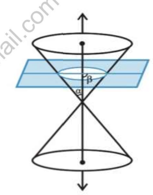


Fig 11. 4

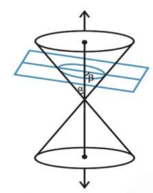


Fig 11. 5

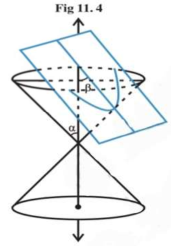


Fig 11. 6

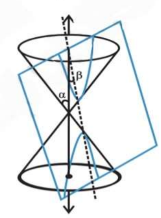


Fig 11. 7

Degenerated conic sections : When the plane cuts at the vertex of the cone, we have the following different cases :

(a) When $\alpha < \beta \le 90^\circ$, then the section is a point.

(b) When $\beta = \alpha$, the plane contains a generator of the cone and the section is a straight line. It is the degenerated case of a parabola.

(c) When $0 \le \beta < \alpha$, the section is a pair of intersecting straight lines. It is degenerated case of a hyperbola.

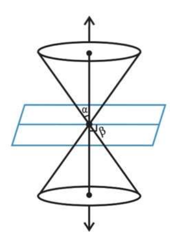


Fig 11.8

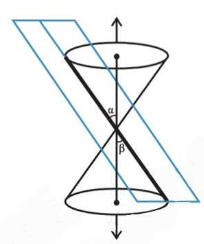


Fig 11. 9

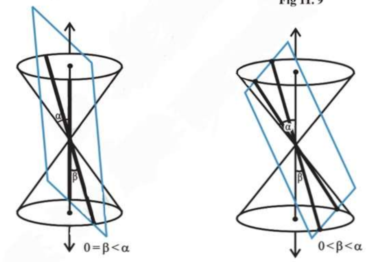
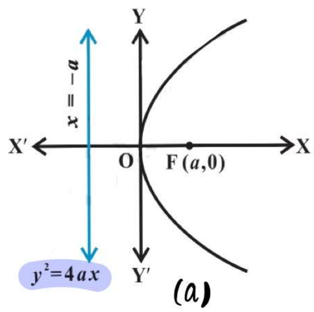
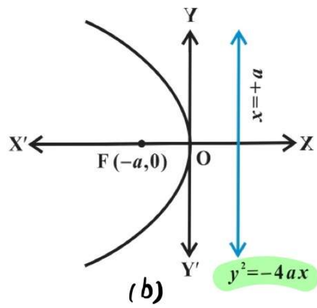


Fig 11. 10

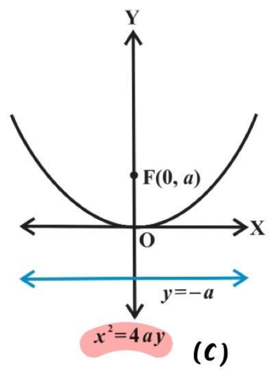
Standard equation of parabola



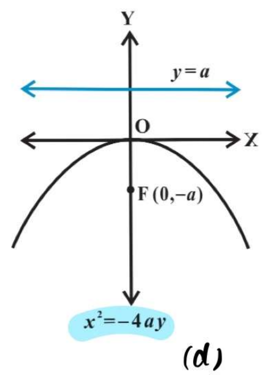
(a)



(b)



(c)



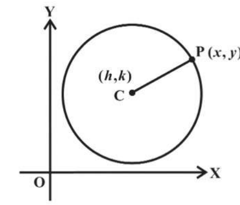
(d)

Circle equation

$$\boxed{(x-h)^2+(y-k)^2=r^2}$$

centre at (h, k)

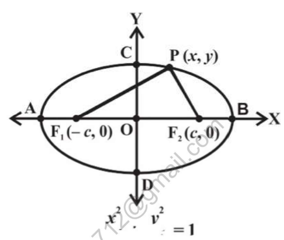
circle radius = r



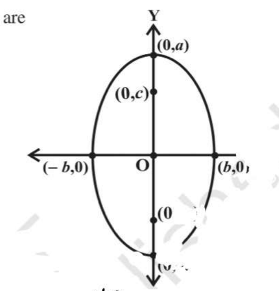
Standard equations of an ellipse

$$\boxed{\frac{x^2}{a^2}+\frac{y^2}{b^2}=1}$$

ntre of the ellipse is at the origin and the foci are



(a)



(b)

Latus rectum of parabola

$$\boxed{4a}$$

Latus rectum of ellipse

$$\boxed{\frac{2b^2}{a}}$$

The eccentricity of an ellipse

$$\boxed{e=\frac{c}{a}}$$

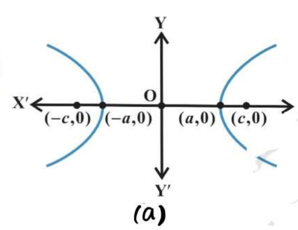
distance from the centre

Relationship between semi-major axis, semi minor axis and the distance of the focus from the centre of the ellipse.

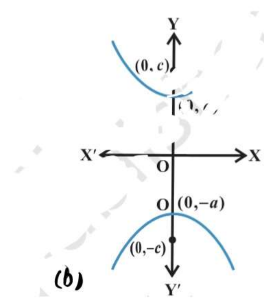
$$\boxed{a^2=b^2+c^2} \quad \text{OR} \quad \boxed{c=\sqrt{a^2-b^2}}$$

Standard equation of hyperbola

$$\boxed{\frac{x^2}{a^2}-\frac{y^2}{b^2}=1}$$



(a)



(b)

Latus rectum of hyperbola

$$\boxed{\frac{2b^2}{a}}$$

The eccentricity of an hyperbola

$$\boxed{e=\frac{c}{a}}$$

distance from the centre

Note: A hyperbola in which a = b is called an equilateral hyperbola.

CHAPTER-11

UNIT-3 (COORDINATE GEOMETRY)

Introduction to Three-dimensional Geometry

- In three dimensions, the coordinate axes of a rectangular Cartesian coordinate system are three mutually perpendicular lines. The axes are called the x, y and z axes.
- The three planes determined by the pair of axes are the coordinate planes, called XY, YZ and ZX- planes
- The three coordinate planes divide the space into eight parts known as octants.
- The coordinates of a point P in three dimensional Geometry is always written in the form of triplet like (x, y, z). Here x, y and z are the distances from the XY, YZ and ZX- planes.

(i) Any point on x-axis is of the form $(x, 0, 0)$

(ii) Any point on y-axis is of the form $(0, y, 0)$

(iii) Any point on z-axis is of the form $(0, 0, z)$

The coordinates of the origin O are $(0, 0, 0)$

- Signs of the coordinates in eight octant :

Octants → / Coordinates ↓	I	II	III	IV	V	VI	VII	VIII
x	+	−	−	+	+	−	−	+
y	+	+	−	−	+	+	−	−
z	+	+	+	+	−	−	−	−

- Distance between two points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$

$$\boxed{PQ = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2}}$$

The coordinates of the point R which divides the line segment joining two points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$ internally and externally in the ratio $m:n$ is given by

$$\left[\frac{mx_2+nx_1}{m+n}, \frac{my_2+ny_1}{m+n}, \frac{mz_2+nz_1}{m+n}\right] \text{ and } \left[\frac{mx_2-nx_1}{m-n}, \frac{my_2-ny_1}{m-n}, \frac{mz_2-nz_1}{m-n}\right]$$

Case I: The coordinates of the mid-point of the line segment joining two points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$ are

$$\left[\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}, \frac{z_1+z_2}{2}\right]$$

Case II: The coordinates of the point R which divides PQ in the ratio $k:1$ are obtained by taking $k = \frac{m}{n}$ which are as given below

$$\left[\frac{kx_2+x_1}{1+k}, \frac{ky_2+y_1}{1+k}, \frac{kz_2+z_1}{1+k}\right]$$

The coordinates of the centroid of the triangle, whose vertices are $(x_1, y_1, z_1), (x_2, y_2, z_2)$ and (x_3, y_3, z_3) are

$$\left[\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3}, \frac{z_1+z_2+z_3}{3}\right]$$

CHAPTER-12

UNIT-4 (CALCULUS)

Limits and Derivatives

limit : If the right and left hand limits equal, then that common value is called the limit of $f(x)$ at $x = a$ and denote it by $\lim_{x\to a} f(x)$.

- $\lim_{x\to a^-} f(x)$ left hand limit of f at a.
- $\lim_{x\to a^-} f(x)$ right hand limit of $f(x)$ at a.

Theorem 1 : Let f and g be two functions such that both $\lim_{x\to a} f(x)$ and $\lim_{x\to a} g(x)$ exist, then

(i) $\boxed{\lim_{x\to a}\left[f(x) \pm g(x)\right] = \lim_{x\to a} f(x) \pm \lim_{x\to a} g(x)}$

(ii) $\boxed{\lim_{x\to a}\left[f(x)\cdot g(x)\right] = \lim_{x\to a} f(x)\cdot \lim_{x\to a} g(x)}$

(iii) $\boxed{\lim_{x\to a}\left[\dfrac{f(x)}{g(x)}\right] = \dfrac{\lim_{x\to a} f(x)}{\lim_{x\to a} g(x)}}$

Theorem 2 : For any positive integer n, $\boxed{\lim_{x\to a} \dfrac{x^n - a^n}{x-a} = na^{n-1}}$

Theorem 3 : Let f and g be any two real valued functions with the same domain such that $f(x) \le g(x)$ for all x in the domain of definition, For some a, if both $\lim_{x\to a} f(x)$ and $\lim_{x\to a} g(x)$ exist, then $\lim_{x\to a} f(x) \le \lim_{x\to a} g(x)$.

Theorem 4 : (Sandwich theorem) : Let f, g and h be real functions such that $f(x) \le g(x) \le h(x)$ for all x in the common domain of definition. For some real number a, if

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

Theorem 5 : The following are two important limits

(i) $\boxed{\lim_{x\to 0} \dfrac{\sin x}{x} = 1}$

(ii) $\boxed{\lim_{x\to 0} \dfrac{1-\cos x}{x} = 0}$

Derivative : The derivative of a function f at a is defined by $\boxed{f'(a) = \lim_{h\to 0} \dfrac{f(a+h) - f(a)}{h}}$

Derivative of a function f at a point x is defined by $\boxed{f'(x) = \dfrac{df(x)}{dx} = \lim_{h\to 0} \dfrac{f(x+h) - f(x)}{h}}$

first principle of derivative

Note : $\boxed{\lim_{x\to a}[(\lambda\cdot f)(x)] = \lambda \lim_{x\to a} f(x)}$

Limits of polynomials and rational functions : A function f is said to be a polynomial function if $f(x)$ is zero function or if $f(x) = a_0 + a_1x + a_2x^2 + \ldots\ldots + a_nx^n$. where a_is are real numbers such that $a_n \neq 0$ for some natural number n

Theorem 6 : For functions u and v the following holds :

(Leibnitz rule)

(i) $(u \pm v)' = u' \pm v'$ (ii) $(uv)' = u'v + uv'$

(iii) $\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}$ provided all are defined

Theorem 7 : $f(x) = x^n \Rightarrow f'(x) = nx^{n-1}$ for any positive integer n.

Theorem 8 : $f(x) = a_nx^n + a_{n-1}x^{n-1} + \ldots\ldots + a_1x + a_0$ be a polynomial function where a_is are all real numbers and $a_n \neq 0$. Then the derivative function is given by

$$\boxed{\frac{df(x)}{dx} = na_nx^{n-1} + (n-1)a_{n-1}x^{x-2} + \ldots\ldots + 2a_2x + a_1}$$

$\boxed{\frac{d}{dx}(x^n) = nx^{n-1}}$ $\boxed{\frac{d}{dx}(\sin x) = \cos x}$ $\boxed{\frac{d}{dx} = -\sin x}$

UNIT-5 (STATISTICS AND PROBABILITY)

CHAPTER-13

Statistics

Mean	$\bar{x} = \frac{\Sigma x}{n}$
Median	If n is odd, then $M = \left(\frac{n+1}{2}\right)^{th}$ term; If n is even, then $M = \frac{\left(\frac{n}{2}\right)^{th} \text{term} + \left(\frac{n+1}{2}\right)^{th} \text{term}}{2}$
Mode	The value which occurs most frequently
Variance	$\sigma^2 = \frac{\Sigma(x-\bar{x})^2}{n}$
Standard Deviation	$S = \sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n}}$

x = observations given

n = Total no. of observations

$\bar{x}$ = Mean

$\boxed{\text{Range = Maximum value - Minimum value}}$

Mean Deviation

$$\text{M.D}(a) = \frac{\text{Sum of absolute values of deviations from 'a'}}{\text{No. of observations}}$$

Mean

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Mean deviation for ungrouped data

Let n observations be $x_1, x_2, x_3, \ldots\ldots x_n$.

$$\text{M.D.}(\bar{x}) = \frac{1}{n}\sum_{i=1}^{n}|x_i - \bar{x}| \quad \& \quad \text{M.D.}(M) = \frac{1}{n}\sum_{i=1}^{n}|x_i - M|$$

$\bar{x}$ = Mean

M = Median

Mean deviation for grouped data

$$(\bar{x}) = \frac{1}{N}\sum_{i=1}^{n} f_i \qquad \text{M.D.}(\bar{x}) = \frac{1}{N}\sum_{i=1}^{n} f_i|x_i - \bar{x}| \qquad \text{M.D.}(M) = \frac{1}{N}\sum_{i=1}^{n} f_i|x_i - M|$$

, where $N = \sum_{i=1}^{n} f_i$

Shortcut method for calculating mean deviation about mean

$$\bar{x} = a + \frac{\sum_{i=1}^{n} f_i d_i}{N} \times h$$

assumed mean (a)

common factor (h)

$$\text{Median} = l + \frac{\frac{N}{2} - C}{f} \times h$$

Variance and standard deviation

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2 \qquad \sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

Variance (σ^2)

Standard deviation (σ)

Cofficient of variation (C.V.)

$$\frac{\sigma}{\bar{x}} \times 100, \quad \bar{x} \neq 0$$

Variance and standard deviation of a discrete frequency distribution

$$\boxed{\sigma^2 = \frac{1}{N}\sum_{i=1}^{n} f_i (x_i - \bar{x})^2}$$

$$\boxed{\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n} f_i (x_i - \bar{x})^2}}$$

Variance and standard deviation of a continuous frequency distribution

$$\boxed{\sigma^2 = \frac{1}{N}\sum_{i=1}^{n} f_i (x_i - \bar{x})^2}$$

$$\boxed{\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n} f_i (x_i - \bar{x})^2}} \quad \text{OR} \quad \boxed{\sigma = \frac{1}{N}\sqrt{N\sum_{i=1}^{n} f_i x_i^2 - \left(\sum_{i=1}^{n} f_i x_i\right)^2}}$$

Shortcut method to find variance and standard deviation

$$\boxed{\sigma^2 = \frac{h^2}{N^2}\left[N\sum_{i=1}^{n} f_i y_i^2 - \left(\sum_{i=1}^{n} f_i y_i\right)^2\right]}$$

$$\boxed{\sigma = \frac{h}{N}\sqrt{N\sum_{i=1}^{n} f_i y_i^2 - \left(\sum_{i=1}^{n} f_i y_i\right)^2}}$$

where $y_i = \frac{x_i - A}{h}$

UNIT-5 (STATISTICS AND PROBABILITY)

CHAPTER-14

Probability

- **Probability formula** : $P(E) = \dfrac{\text{Number of favourable outcomes}}{\text{Total number of outcomes}}$

- **Outcomes space** : A possible result of a random experiment is called its outcome.

- **Sample space** : The set of outcomes is called the sample space of the experiment.

- **Sample point** : Each element of the sample space is called a sample point.

- **Event** : Any subset E of a sample space S is called an event.

- **Types of events**

1. **Impossible Events and Sure Events** : The empty set ϕ Impossible Events.
   The whole sample space S Sure Events.
2. **Simple Event** : If any event E has only one sample point of a sample space, it is called a simple event. (Elementary Event)
3. **Compound Event** : If an event has more than one sample point, it is called a compound event.

- **Algebra of events**

1. **Complementary Event of A** : The Set A' or $S - A$
2. **The Event 'A' or 'B'** : The set $A \cup B$
3. **The Event 'A' and 'B'** : The set $A \cap B$
4. **The Event 'A' but not 'B'** : The set $A - B$

- **Mutually exclusive events** : A and B are mutually exclusive if $A \cap B = \phi$

  Note : Simple events of a sample space are always mutually exclusive.

- **Exhaustive Events** : If $E_1, E_2, \ldots, E_n$ are n events of a sample space S and if $\boxed{E_1 \cup E_2 \cup \ldots \cup E_n = \bigcup_{i=1}^{n} E_i = S}$ then $E_1, E_2, \ldots, E_n$ are called exhaustive events.

Probability : Number $P(\omega_i)$ associated with sample point ω_i such that.

(i) $0 \le P(\omega_i) \le 1$

(ii) $\Sigma P(\omega_i)$ for all $\omega_i \in S = 1$

(iii) $P(A) = \Sigma P(\omega_i)$ for all $\omega_i \in A$

The no. of $P(\omega_i)$ is called probability of the outcome ω_i.

Equally likes outcomes : All outcomes with equal probability

Probability of an event : For a finite sample space with equally likely outcomes.

$$\boxed{P(A) = \frac{n(A)}{n(S)}}$$

$n(A)$ → number of elements in the set A

$n(S)$ → number of elements in the set S

If A and B are any two events, then $\boxed{P(A \cup B) = P(A) + P(B) - P(A \cap B)}$

If A and B are mutually exclusive, then $\boxed{P(A \cup B) = P(A) + P(B)}$

If A is any event then $\boxed{P(\text{not } A) = 1 - P(A)}$

Conditional Probability : If E and F are two events with the same space of a random experiment, then the conditional Probability of the event E gives that F has occured i.e. $\boxed{P\left(\frac{E}{F}\right) = \frac{P(E \cap F)}{P(F)}, \text{ provided } P(F) \neq 0}$

Probability of Conditional Probability

1. $\boxed{P\left(\frac{S}{F}\right) = P\left(\frac{F}{F}\right) = 1}$

2. If A and B are two events in a sample space S and F is an event of S, such that $P(F) \neq 0$ then; $\boxed{P\left(\frac{A \cup B}{F}\right) = P\left(\frac{A}{F}\right) + P\left(\frac{B}{F}\right) - P\left(\frac{A \cap B}{F}\right)}$

3. $\boxed{P\left(\frac{E'}{F}\right) = 1 - P\left(\frac{E}{F}\right)}$