

Math Mastery for NET

Complete Chapter-wise Guide

Chapters (as per PTB & NET syllabus):

1. Functions and Limits
2. Differentiation
3. Integration
4. Trigonometry
5. Matrices and Determinants
6. Complex Numbers
7. Coordinate Geometry
8. Conic Sections
9. Sequences and Series
10. Probability and Statistics
11. Vectors
12. Application of Derivatives

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Chapter: Functions and Limits

Definition of a Function:

A function f is a rule that assigns each input x to exactly one output $f(x)$.

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

IMPORTANT FORMULAS:

Trigonometric Limits:

$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = \lim_{x \rightarrow 0} \frac{x}{\sin x} = 1$$

$$\lim_{x \rightarrow 0} \frac{\tan x}{x} = \lim_{x \rightarrow 0} \frac{x}{\tan x} = 1$$

$$\lim_{x \rightarrow 0} \frac{1 - \cos x}{x} = 0$$

$$\lim_{x \rightarrow 0} \frac{\sin^{-1}(x)}{x} = \lim_{x \rightarrow 0} \frac{x}{\sin^{-1}(x)} = 1$$

$$\lim_{x \rightarrow 0} \frac{\tan^{-1}(x)}{x} = \lim_{x \rightarrow 0} \frac{x}{\tan^{-1}(x)} = 1$$

$$\lim_{x \rightarrow a} \frac{\sin(x-a)}{x-a} = \lim_{x \rightarrow a} \frac{\tan(x-a)}{x-a} = 1$$

$$\lim_{x \rightarrow \infty} \frac{\sin(1/x)}{1/x} = 1$$

$$\lim_{x \rightarrow \infty} \frac{\sin x}{x} = \lim_{x \rightarrow \infty} \frac{\cos x}{x} = 0$$

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Exponential Limits:

$$\lim_{x \rightarrow 0} e^x = 1 \lim_{x \rightarrow 0} \frac{e^x - 1}{x} = 1$$

$$\lim_{x \rightarrow \infty} \left[1 + \frac{1}{x} \right]^x = \lim_{x \rightarrow \infty} \left[\frac{x+1}{x} \right]^x = e$$

$$\lim_{x \rightarrow 0} [1+x]^{1/x} = e \lim_{x \rightarrow \infty} \left[1 + \frac{a}{x} \right]^x = e^a$$

Logarithmic Limits:

$$\lim_{x \rightarrow 0} \frac{\ln(1+x)}{x} = 1 \lim_{x \rightarrow 0} \frac{a^x - 1}{x} = \ln a$$

Other Limits:

$$\lim_{x \rightarrow 0} \frac{[1+x]^n - 1}{x} = n$$

Identities

$$f(x) = \frac{ax + b}{cx + d} \text{ (Rational function)}$$

$$\lim_{x \rightarrow a} (x^2 - a^2)/(x - a) = a + x$$

$$\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = n \cdot a^{n-1}$$

For continuity:

$$f(a) \text{ is defined, } \lim_{x \rightarrow a} f(x) \text{ exists, } \lim_{x \rightarrow a} f(x) = f(a)$$

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Graphs Overview

Linear Function: Straight line

$$f(x) = mx + c$$

Quadratic Function: Parabola

$$f(x) = ax^2 + bx + c$$

Rational Function: Hyperbola-like graph

$$f(x) = \frac{1}{x}, \frac{x+1}{x-1}$$

Trigonometric Function:

Sine and cosine waveforms repeat every 2π

Exponential Function:

Rapid growth: $f(x) = a^x$

Logarithmic Function:

Slowly increasing: $f(x) = \log_b x$

Discontinuities:

Jump, infinite, or removable discontinuities shown with breaks or holes

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MCQ Tips / Tricks

1. Use direct substitution first in limit problems.
2. If substitution gives $0/0$, factorize or rationalize.
3. For continuity questions, match $LHL = RHL = f(a)$.
4. Understand which form is indeterminate — don't directly simplify.
5. Use graphs to quickly estimate behavior near discontinuities.
6. If limit involves ∞/∞ , divide by the highest power of x .
7. Remember: piecewise functions must match at joining points.

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Chapter: Differentiation

Important Formulas:

1. $\frac{d}{dx} (x^n) = n \cdot x^{n-1}$
2. $\frac{d}{dx} (\sin x) = \cos x$
3. $\frac{d}{dx} (\cos x) = -\sin x$
4. $\frac{d}{dx} (\tan x) = \sec^2 x$
5. $\frac{d}{dx} (\sec x) = \sec x \cdot \tan x$
6. $\frac{d}{dx} (\csc x) = -\csc x \cdot \cot x$
7. $\frac{d}{dx} (\cot x) = -\csc^2 x$
8. $\frac{d}{dx} (e^x) = e^x$
9. $\frac{d}{dx} (\ln x) = 1/x$
10. $\frac{d}{dx} (\log_a x) = 1 / (x \cdot \ln a)$
11. **Product Rule:**
 $\frac{d}{dx} (u \cdot v) = u' \cdot v + u \cdot v'$
12. **Quotient Rule:**
 $\frac{d}{dx} (u / v) = [v \cdot u' - u \cdot v'] / v^2$
13. **Chain Rule:**
 $\frac{d}{dx} [f(g(x))] = f'(g(x)) \cdot g'(x)$
14. $\frac{d}{dx} (\sqrt{x}) = 1 / (2\sqrt{x})$
15. $\frac{d}{dx} (a^x) = a^x \cdot \ln a$
16. $\frac{d}{dx} (\arcsin x) = 1 / \sqrt{1 - x^2}$
17. $\frac{d}{dx} (\arccos x) = -1 / \sqrt{1 - x^2}$
18. $\frac{d}{dx} (\arctan x) = 1 / (1 + x^2)$
19. $\frac{d}{dx} (x^x) = x^x \cdot (1 + \ln x)$

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20. If $y^2 + x^2 = 1$, then $dy/dx = -x / y$

21. $d/dx (\sin^{-1}x) = 1 / \sqrt{1 - x^2}$

22. $d/dx (|x|) = x / |x|$, for $x \neq 0$

Identities:

- Chain Rule again:
 $d/dx [f(g(x))] = f'(g(x)) \cdot g'(x)$
- If $y = x^n$, then:
 $d^2y/dx^2 = n(n-1)x^{n-2}$
- For parametric form:
 $dy/dx = (dy/dt) / (dx/dt)$
- Logarithmic Differentiation:
If $y = f(x)^{g(x)}$, take log on both sides:
 $\ln y = g(x) \cdot \ln f(x)$, then differentiate.

Graphs Overview:

- $f'(x) > 0 \Rightarrow$ Function is increasing
 - $f'(x) < 0 \Rightarrow$ Function is decreasing
 - $f'(x) = 0 \Rightarrow$ Critical point (check $f''(x)$)
 - $f''(x) > 0 \Rightarrow$ Local minimum
 - $f''(x) < 0 \Rightarrow$ Local maximum
 - $f''(x) = 0 \Rightarrow$ Possible point of inflection
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MCQ Tips / Tricks

1. Use power rule unless something complex is given
2. Always try to simplify before differentiating
3. Use product or quotient rule when two functions are multiplied/divided
4. Use chain rule on composite functions like $\sin(3x)$
5. Know special derivatives like:
 - $\frac{d}{dx}(\sin x) = \cos x$
 - $\frac{d}{dx}(\tan x) = \sec^2 x$
 - $\frac{d}{dx}(\ln x) = 1/x$
6. For maximum/minimum problems, set $f'(x) = 0$
7. Use units or values in word problems to guess correct answer
8. Sometimes plugging values (like $x = 0$ or 1) in options saves time

■ Past NET MCQs Examples Q1:

Find derivative of: $f(x) = x^3 + 3x^2 + 2x$

A. $3x^2 + 6x + 2$

B. $3x^2 + 2x + 3$

C. $2x + 6$

D. $3x + 6x^2 + 2$

✓ **Correct Answer: A**

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Q2: If $y = \ln(\sin x)$, what is dy/dx ?

- A. $\cot x$
- B. $\tan x$
- C. $\cos x$
- D. $1 / \sin x$

✓ **Correct Answer: A**

(Use chain rule: $d/dx [\ln(\sin x)] = (1/\sin x) \cdot \cos x = \cot x$)

Q3:

$y = e^{2x} \cdot \sin x$, find dy/dx :

- A. $e^{2x} \cdot (2 \sin x + \cos x)$
- B. $e^{2x} \cdot (2 \cos x + \sin x)$
- C. $e^{2x} \cdot (\cos x - \sin x)$
- D. $e^{2x} \cdot \cos x$

✓ **Correct Answer: A**

(Use product + chain rule)

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Chapter: Integration

Important Formulas

1. $\int x^n dx = (x^{n+1})/(n+1) + C \quad (n \neq -1)$
2. $\int 1/x dx = \ln|x| + C$
3. $\int e^x dx = e^x + C$
4. $\int a^x dx = a^x / \ln(a) + C$
5. $\int \sin x dx = -\cos x + C$
6. $\int \cos x dx = \sin x + C$
7. $\int \tan x dx = \ln|\sec x| + C$
8. $\int \cot x dx = \ln|\sin x| + C$
9. $\int \sec x dx = \ln|\sec x + \tan x| + C$
10. $\int \csc x dx = -\ln|\csc x + \cot x| + C$
11. $\int \sec^2 x dx = \tan x + C$
12. $\int \csc^2 x dx = -\cot x + C$
13. $\int \sec x \cdot \tan x dx = \sec x + C$
14. $\int \csc x \cdot \cot x dx = -\csc x + C$
15. $\int dx / \sqrt{a^2 - x^2} = \sin^{-1}(x/a) + C$
16. $\int dx / \sqrt{a^2 + x^2} = \sinh^{-1}(x/a) + C$
17. $\int dx / (a^2 + x^2) = (1/a) \cdot \tan^{-1}(x/a) + C$
18. $\int dx / (x^2 - a^2) = (1/2a) \cdot \ln|(x-a)/(x+a)| + C$
19. $\int \ln x dx = x \ln x - x + C$
20. $\int u \cdot dv = u \cdot v - \int v \cdot du \quad (\text{Integration by parts})$
21. $\int (ax + b)^n dx = ((ax + b)^{n+1}) / (a(n+1)) + C$

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$$22. \int dx / (x^2 + a^2) = (1/a) \cdot \tan^{-1}(x/a) + C$$

$$23. \int x \cdot e^x dx = e^x(x - 1) + C$$

$$24. \int x \cdot \ln x dx = (x^2/2) \cdot \ln x - x^2/4 + C$$

$$25. \int dx / (x \cdot \ln x) = \ln|\ln x| + C$$

Identities and Techniques

- Substitution:
Let u = function inside $\rightarrow$ simplify the integral
- Integration by Parts:
Use ILATE rule (Inverse, Log, Algebraic, Trig, Exponential)
 u = first choice, dv = rest
- Partial Fractions (for rational expressions)
- Trig Substitution:
 - $x = a \sin \theta \Rightarrow$ for $\sqrt{a^2 - x^2}$
 - $x = a \tan \theta \Rightarrow$ for $\sqrt{a^2 + x^2}$

Graphs Overview

- $\int f(x) dx$ = Area under curve from a to b
 - Positive function $\Rightarrow$ area above x -axis
 - Negative function $\Rightarrow$ area below x -axis
 - Discontinuous functions can't be integrated in standard way
 - Graphs of exponential and log functions help identify areas
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MCQ Tips / Tricks

1. Try substitution first if function is nested
 2. For $\int x \cdot f(x) dx \rightarrow$ consider by parts
 3. Recognize common integral patterns
 4. Don't forget the constant of integration (+ C)
 5. Use derivative knowledge to check your answer
 6. For limits and definite integrals, apply bounds after solving
 7. For even functions over symmetric intervals $[-a, a]$, area is $2 \times \int_0^a f(x) dx$
 8. For odd functions over $[-a, a]$, total area is 0
 9. Logarithmic integrals often appear in options — look for $\ln|\dots|$
 10. Try differentiating MCQ options if unsure
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Past NET MCQs Examples

Q1:

$$\int x^2 dx = ?$$

A. $x^2/2 + C$

B. $x^3/3 + C$

C. $2x + C$

D. $x^3/2 + C$

 **Correct: B**

Q2:

$$\text{What is } \int dx / (1 + x^2)?$$

A. $\tan^{-1}x + C$

B. $\ln(1 + x^2) + C$

C. $-\cot^{-1}x + C$

D. $\sec^{-1}x + C$

 **Correct: A**

Q3:

$$\text{What is } \int e^x \sin x dx ?$$

A. $e^x(\sin x - \cos x)/2 + C$

B. $e^x(\sin x + \cos x)/2 + C$

C. $e^x(\sin x - \ln x) + C$

D. $e^x(1 + \sin x) + C$

 **Correct: A**

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Chapter: Trigonometry

Important Formulas

1. $\sin^2 x + \cos^2 x = 1$
2. $1 + \tan^2 x = \sec^2 x$
3. $1 + \cot^2 x = \csc^2 x$
4. $\sin(2x) = 2 \sin x \cdot \cos x$
5. $\cos(2x) = \cos^2 x - \sin^2 x = 2\cos^2 x - 1 = 1 - 2\sin^2 x$
6. $\tan(2x) = 2 \tan x / (1 - \tan^2 x)$
7. $\sin(x \pm y) = \sin x \cdot \cos y \pm \cos x \cdot \sin y$
8. $\cos(x \pm y) = \cos x \cdot \cos y \mp \sin x \cdot \sin y$
9. $\tan(x \pm y) = (\tan x \pm \tan y) / (1 \mp \tan x \cdot \tan y)$
10. $\sin^2 x = (1 - \cos 2x) / 2$
11. $\cos^2 x = (1 + \cos 2x) / 2$
12. $\sin A + \sin B = 2 \sin[(A+B)/2] \cos[(A-B)/2]$
13. $\sin A - \sin B = 2 \cos[(A+B)/2] \sin[(A-B)/2]$
14. $\cos A + \cos B = 2 \cos[(A+B)/2] \cos[(A-B)/2]$
15. $\cos A - \cos B = -2 \sin[(A+B)/2] \sin[(A-B)/2]$
16. $\tan x = \sin x / \cos x$
17. $\cot x = \cos x / \sin x$
18. $\sec x = 1 / \cos x$
19. $\csc x = 1 / \sin x$
20. $\sin(-x) = -\sin x, \quad \cos(-x) = \cos x$
21. $\sin(\pi - x) = \sin x, \quad \cos(\pi - x) = -\cos x$

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22. $\sin(90^\circ \pm x) = \cos x$, $\cos(90^\circ \pm x) = \sin x$

23. $\sin(x) = \cos(90^\circ - x)$, $\tan(x) = \cot(90^\circ - x)$

24. If $\sin A = \cos B \Rightarrow A + B = 90^\circ$

25. Law of Sines: $a/\sin A = b/\sin B = c/\sin C$

26. Law of Cosines:

○ $c^2 = a^2 + b^2 - 2ab \cos C$

Identities

- $\sin^2 x + \cos^2 x = 1$
 - $1 + \tan^2 x = \sec^2 x$
 - $1 + \cot^2 x = \csc^2 x$
 - Reciprocal identities:
 - $\sin x = 1 / \csc x$
 - $\cos x = 1 / \sec x$
 - $\tan x = 1 / \cot x$
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Graphs Overview

- $\sin x$: Starts from 0, max at $\pi/2$, min at $3\pi/2$, periodic with 2π
 - $\cos x$: Starts from 1, min at π , periodic with 2π
 - $\tan x$: Undefined at $\pi/2, -\pi/2$, increasing curve, period π
 - $\csc x, \sec x$: Have vertical asymptotes and U-shaped graphs
 - $\cot x$: Decreasing graph with undefined values at $0, \pi$, etc.
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MCQ Tips / Tricks

1. Convert degrees to radians if needed: $\pi \text{ rad} = 180^\circ$
 2. Use $\sin^2 x + \cos^2 x = 1$ to simplify complex expressions
 3. Know sin/cos/tan values at $0^\circ, 30^\circ, 45^\circ, 60^\circ, 90^\circ$
 4. For maximum/minimum of sin/cos, range is $[-1, 1]$
 5. Use graphs to visualize behavior of functions
 6. Use transformation identities to match options
 7. Remember:
 - $\sin A = \cos(90^\circ - A)$
 - $\tan(90^\circ - A) = \cot A$
 8. If stuck, plug in values like $x = 30^\circ$ to test MCQ answers
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Past NET MCQs Examples

Q1:

If $\sin x = 3/5$, $\cos x = ?$

A. $4/5$

B. $\sqrt{(3)}/5$

C. $5/3$

D. None



Answer: A

(Use $\sin^2 x + \cos^2 x = 1$)

Q2:

$\cos 75^\circ = ?$

A. $\sqrt{2}/2$

B. $\cos(45^\circ + 30^\circ)$

C. $\cos(45^\circ - 30^\circ)$

D. 0.5



Answer: B

(Use $\cos(A+B) = \cos A \cdot \cos B - \sin A \cdot \sin B$)

Q3:

If $\tan x = 1$, then $x = ?$

A. 0

B. 45°

C. 60°

D. 90°



Answer: B

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Chapter: Matrices and Determinants

Important Formulas :

1. Matrix Addition: $A + B = [a_{ij} + b_{ij}]$
2. Matrix Subtraction: $A - B = [a_{ij} - b_{ij}]$
3. Scalar Multiplication: $kA = [k \cdot a_{ij}]$
4. Matrix Multiplication: $A \cdot B$ is valid if (columns of A = rows of B)
5. Transpose: $(A^T)_{ij} = A_{ji}$
6. Determinant of 2×2 : $|A| = ad - bc$
7. Determinant of 3×3 : Use Sarrus Rule or Cofactor Expansion
8. Inverse (2×2 Matrix): $A^{-1} = (1/|A|) \times \text{adj}(A)$
9. Adjoint of 2×2 Matrix: Swap diagonal, change signs of off-diagonal
10. Identity Matrix (I): $I \cdot A = A \cdot I = A$
11. Zero Matrix: All elements are 0
12. Symmetric Matrix: $A = A^T$
13. Skew-Symmetric Matrix: $A^T = -A$
14. Diagonal Matrix: All non-diagonal entries = 0
15. Orthogonal Matrix: $A \cdot A^T = I$
16. $|AB| = |A| \times |B|$
17. $|A^T| = |A|$
18. $|A^{-1}| = 1 / |A|$
19. Rank of Matrix: Maximum order of a non-zero minor
20. Cofactor: $C_{ij} = (-1)^{i+j} \times \text{Minor}_{ij}$

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- 21. Determinant = 0 $\Rightarrow$ Non-Invertible (Singular)
 - 22. Trace: Sum of diagonal elements
 - 23. If $AB = BA \Rightarrow A$ and B are commutative (rare)
 - 24. Inverse of a 3×3 matrix: $A^{-1} = \text{adj}(A) / \det(A)$
 - 25. Minor: Determinant of a submatrix formed by deleting row and column
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Identities:

- $(A^T)^T = A$
 - $(A + B)^T = A^T + B^T$
 - $(AB)^T = B^T \cdot A^T$
 - $(kA)^T = k \cdot A^T$
 - $|A^T| = |A|$
 - $|kA| = k^n \times |A|$ (where n is the order of the matrix)
 - $\text{adj}(A) \cdot A = A \cdot \text{adj}(A) = |A| \cdot I$
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MCQ Tips / Tricks

1. Use determinant formula for 2×2 and 3×3 carefully
2. Inverse exists only when $|A| \neq 0$
3. Matrix multiplication is not commutative ($AB \neq BA$)
4. Transpose flips rows $\leftrightarrow$ columns
5. Identity matrix has 1s on the diagonal, 0s elsewhere
6. For trace, just add diagonal entries
7. Skew-symmetric: main diagonal = 0
8. Cofactors have alternating signs (+, -, +, ...)

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9. Use Sarrus rule for quick 3×3 determinant
10. Check matrix dimensions before performing operations

Past NET MCQs Examples:

Q1:

If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, what is $|A|$?

A. 2 B. -2 C. 10 D. 5

☒ Correct: B ($1 \times 4 - 2 \times 3 = 4 - 6 = -2$)

Q2:

Which of the following is a symmetric matrix?

- A. $\begin{bmatrix} 2 & 3 \\ 3 & 2 \end{bmatrix} \begin{bmatrix} 2 & 3 \\ 3 & 2 \end{bmatrix}$
B. $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$
C. $\begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}$
D. $\begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$

☒ Correct: A

Q3:

If $\det(A) = 5$, then $\det(A^{-1}) = ?$

A. 0.2 B. 5 C. -5 D. 25

☒ Correct: A

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Chapter: Complex Numbers

Important Formulas :

1. $i^2 = -1$
2. $i^3 = -i$, $i^4 = 1$, $i^5 = i$, and so on (cyclic every 4 powers)
3. **Standard form:** $z = a + bi$ (where a = real, b = imaginary)
4. **Conjugate:** If $z = a + bi \Rightarrow \bar{z} = a - bi$
5. **Modulus:** $|z| = \sqrt{a^2 + b^2}$
6. **Argument:** $\arg(z) = \tan^{-1}(b/a)$
7. **Addition:** $(a + bi) + (c + di) = (a + c) + (b + d)i$
8. **Subtraction:** $(a + bi) - (c + di) = (a - c) + (b - d)i$
9. **Multiplication:** $(a + bi)(c + di) = (ac - bd) + (ad + bc)i$
10. **Division:** Multiply numerator and denominator by conjugate
11. **Reciprocal:** $1/z = \bar{z} / |z|^2$
12. **De Moivre's Theorem:**
 $(r \cdot \text{cis}\theta)^n = r^n \cdot \text{cis}(n\theta)$, where $\text{cis}\theta = \cos\theta + i \cdot \sin\theta$
13. **Euler's Formula:** $e^{i\theta} = \cos\theta + i \cdot \sin\theta$
14. **Trigonometric Form:** $z = r \cdot (\cos\theta + i \cdot \sin\theta)$
15. **Polar Form:** $z = r \cdot \text{cis}\theta$
16. **Roots of Unity:** Solutions to $z^n = 1$ in complex plane
17. **Quadratic Roots:** If $D < 0$, roots are complex
18. $z \cdot \bar{z} = |z|^2$
19. $\arg(z_1 \cdot z_2) = \arg(z_1) + \arg(z_2)$
20. $\arg(z_1/z_2) = \arg(z_1) - \arg(z_2)$

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$$21. |z_1 \cdot z_2| = |z_1| \cdot |z_2|$$

$$22. |z_1/z_2| = |z_1| / |z_2|$$

$$23. (a + bi)^n = \text{Expand using binomial or De Moivre's}$$

$$24. \text{Real Part: } \operatorname{Re}(z) = a$$

$$25. \text{Imaginary Part: } \operatorname{Im}(z) = b$$

Identities:

- $i^2 = -1, i^4 = 1, i^6 = -1, \dots$
- $z \cdot \bar{z} = |z|^2$
- $\operatorname{Re}(z) = (z + \bar{z})/2$
- $\operatorname{Im}(z) = (z - \bar{z})/2i$
- $z^n = r^n \cdot \operatorname{cis}(n\theta) \rightarrow \text{Use De Moivre's Theorem}$

Graphs Overview:

- Complex numbers are plotted on **Argand Plane**
 - **x-axis = Real part, y-axis = Imaginary part**
 - Modulus $|z|$ is the **distance from origin**
 - Argument is the **angle** with positive real axis
 - Multiplying by $i = 90^\circ$ **rotation counterclockwise**
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MCQ Tips / Tricks:

1. Simplify powers of i using the cycle $(i, -1, -i, 1)$
 2. For conjugate: just change sign of imaginary part
 3. Use modulus and argument formulas carefully
 4. Convert complex expressions into standard form before solving
 5. If asked for roots: check quadratic nature ($a + bi$ form)
 6. Practice basic operations: addition, multiplication, etc.
 7. Check if $z \cdot \bar{z} = |z|^2$ for quick verification
 8. For n th roots of unity $\rightarrow$ equally spaced points on a circle
 9. Practice converting polar $\leftrightarrow$ rectangular forms
 10. Plug in simple values (like $i^2 = -1$) to eliminate wrong options
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Past NET MCQs Examples:

Q1:

What is i^{100} ?

A. i B. -1 C. $-i$ D. 1

☒ **Correct: D**

(Use $i^4 = 1 \rightarrow 100 \div 4 = 25 \text{ cycles} \Rightarrow i^{100} = 1$)

Q2:

If $z = 3 + 4i$, then $|z| = ?$

A. 5 B. 7 C. 6 D. $\sqrt{7}$

☒ **Correct: A**

($|z| = \sqrt{3^2 + 4^2} = \sqrt{25} = 5$)

Q3:

Conjugate of $(2 - 5i) = ?$

A. $-2 - 5i$ B. $2 + 5i$ C. $2 - 5i$ D. $-2 + 5i$

☒ **Correct: B**

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Chapter: Coordinate Geometry

Important Formulas :

1. **Distance Between Two Points:**

$$D = \sqrt{[(x_2 - x_1)^2 + (y_2 - y_1)^2]}$$

2. **Midpoint Formula:**

$$M = ((x_1 + x_2)/2, (y_1 + y_2)/2)$$

3. **Section Formula (Internal):**

$$(x, y) = ((m \cdot x_2 + n \cdot x_1)/(m + n), (m \cdot y_2 + n \cdot y_1)/(m + n))$$

4. **Slope (Gradient):**

$$m = (y_2 - y_1) / (x_2 - x_1)$$

5. **Equation of Line (Slope–Intercept Form):**

$$y = mx + c$$

6. **Point–Slope Form:**

$$y - y_1 = m(x - x_1)$$

7. **Two-Point Form:**

$$y - y_1 = ((y_2 - y_1)/(x_2 - x_1)) \cdot (x - x_1)$$

8. **General Equation of Line:**

$$Ax + By + C = 0$$

9. **Intercept Form:**

$$x/a + y/b = 1$$

10. **Parallel Lines:**

$$\text{Slopes are equal} \Rightarrow m_1 = m_2$$

11. **Perpendicular Lines:**

$$m_1 \cdot m_2 = -1$$

12. **Angle Between Two Lines:**

$$\tan \theta = |(m_1 - m_2)/(1 + m_1 \cdot m_2)|$$

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13. Collinearity Condition:

Area of triangle = 0
or Slopes of all points are equal

14. Area of Triangle (using coordinates):

$$A = (1/2)|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$$

15. Centroid of Triangle:

$$G = ((x_1 + x_2 + x_3)/3, (y_1 + y_2 + y_3)/3)$$

16. Orthocenter, Circumcenter:

Use intersection of altitudes/perpendicular bisectors

17. Locus:

Set of points satisfying a condition

18. Circle Equation (Center at origin):

$$x^2 + y^2 = r^2$$

19. Circle Equation (Center at (h, k)):

$$(x - h)^2 + (y - k)^2 = r^2$$

20. Parabola Standard Equation:

$$y^2 = 4ax \text{ or } x^2 = 4ay$$

21. Ellipse Equation:

$$x^2/a^2 + y^2/b^2 = 1$$

22. Hyperbola Equation:

$$x^2/a^2 - y^2/b^2 = 1$$

23. Length of Perpendicular from Point to Line:

$$D = |Ax + By + C| / \sqrt{A^2 + B^2}$$

24. Circle touches coordinate axes:

Radius = h = k, if center = (h, k)

25. Slope of line $ax + by + c = 0$:

$$m = -A/B$$

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Identities:

- Two lines are **perpendicular** if $m_1 \cdot m_2 = -1$
 - Two lines are **parallel** if $m_1 = m_2$
 - Slopes form a basis for most line-related identities
 - Distance and midpoint formulas form the base of triangle geometry
-

Graphs Overview:

- **Straight lines:** Defined by slope and y-intercept
 - **Circles:** All points equidistant from center
 - **Parabolas:** Open in x or y depending on equation
 - **Ellipses and Hyperbolas:** Closed/open curves centered at origin or shifted
 - Graph helps in identifying intersection, tangency, and symmetry
-

MCQ Tips / Tricks:

1. For shortest distance, use perpendicular formula
 2. If slope is not defined $\rightarrow$ vertical line ($x = a$)
 3. Check slope signs to find relation between lines (parallel or perpendicular)
 4. Use coordinate formulas rather than graph estimation
 5. Draw diagrams to visualize triangle or line segment problems
 6. Recognize standard forms of conic sections quickly
 7. Convert given data into general line equation when needed
 8. Use midpoint and section formulas to avoid manual distance splitting
 9. Try checking options with plug-in values
-

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■ Past NET MCQs Examples Q1:

Find distance between points (3, 4) and (0, 0)

A. 4 B. 5 C. $\sqrt{13}$ D. 3

■ **Correct: B** ($\sqrt{(3^2 + 4^2)} = \sqrt{25} = 5$)

Q2:

If a line has slope 2 and passes through (1, 1), its equation is:

A. $y = 2x - 1$ B. $y = x + 1$ C. $y = 2x + 1$ D. $y = -2x + 1$

✓ **Correct: C**

Q3:

Find area of triangle with vertices (0, 0), (4, 0), (0, 3)

A. 12 B. 6 C. 7 D. 8

■ **Correct: B** ($\frac{1}{2} \times 4 \times 3 = 6$)

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Chapter: Conic Sections

Important Formulas:

Circle

1. **Standard Form:** $(x - h)^2 + (y - k)^2 = r^2$
 2. **Centre:** (h, k)
 3. **Radius:** r
 4. **General Form:** $x^2 + y^2 + Dx + Ey + F = 0$
 5. **Convert General to Standard** using completing square
 6. **Length of Chord:** $2\sqrt{(r^2 - d^2)}$, where d = distance from center to chord
 7. **Diameter:** $2r$
 8. **Equation of Circle touching x and y axes:** $(x - a)^2 + (y - a)^2 = a^2$
-

Parabola

9. **Standard Form (Opening Right/Left):** $y^2 = 4ax$
 10. **Standard Form (Opening Up/Down):** $x^2 = 4ay$
 11. **Vertex:** $(0, 0)$
 12. **Focus:** $(\pm a, 0)$ or $(0, \pm a)$
 13. **Directrix:** $x = -a$ or $y = -a$
 14. **Axis of Symmetry:** $x = 0$ or $y = 0$
 15. **Length of Latus Rectum:** $4a$
-

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Ellipse

16. **Standard Form:** $x^2/a^2 + y^2/b^2 = 1$

17. **a > b:** Major axis along x-axis

18. **Foci:** $(\pm c, 0)$ where $c^2 = a^2 - b^2$

19. **Vertices:** $(\pm a, 0)$ or $(0, \pm a)$

20. **Length of Major Axis:** $2a$

21. **Length of Minor Axis:** $2b$

Hyperbola

22. **Standard Form:** $x^2/a^2 - y^2/b^2 = 1$

23. **Foci:** $(\pm c, 0)$, where $c^2 = a^2 + b^2$

24. **Vertices:** $(\pm a, 0)$

25. **Asymptotes:** $y = \pm(b/a)x$

Identities & Concepts:

- Circle: All points equidistant from a center
 - Parabola: Set of points equidistant from a focus and directrix
 - Ellipse: Sum of distances from two foci is constant
 - Hyperbola: Difference of distances from two foci is constant
-

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Graphs Overview:

- **Circle:** Perfect round shape centered at (h, k)
 - **Parabola:** U-shaped curve opening along x or y axis
 - **Ellipse:** Stretched circle (oval shape)
 - **Hyperbola:** Two open curves, mirror images about center
 - Graphs help visualize vertex, axis, and asymptotes
-

MCQ Tips / Tricks:

1. Learn to identify type by equation form
 2. Complete the square to convert general $\rightarrow$ standard form
 3. In parabola: if $y^2 =$, it opens along x-axis; if $x^2 =$, it opens along y-axis
 4. Use $a^2 - b^2 = c^2$ for ellipse; $a^2 + b^2 = c^2$ for hyperbola
 5. Foci lie along major axis (ellipse/hyperbola)
 6. Asymptotes appear only in hyperbola
 7. If coefficients of x^2 and y^2 are equal $\Rightarrow$ Circle
 8. Ellipse vs. Hyperbola: look at signs between terms ($\pm$)
 9. Focus helps determine reflection properties
 10. Plug in options to check satisfaction of conic equations
-

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Past NET MCQs Examples:

Q1:

Which conic section is given by $x^2 + y^2 = 25$?

A. Ellipse B. Circle C. Parabola D. Hyperbola

✓ **Correct: B**

Q2:

The parabola $y^2 = 12x$ has its focus at:

A. (3, 0) B. (6, 0) C. (0, 3) D. (0, -3)

■ **Correct: A**

(Compare with $y^2 = 4ax \Rightarrow 4a = 12 \Rightarrow a = 3$)

Q3:

For ellipse $x^2/25 + y^2/9 = 1$, major axis is along:

A. y-axis B. x-axis C. diagonal D. none

■ **Correct: B**

($a^2 = 25 > b^2 = 9 \Rightarrow$ major axis along x-axis)

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Chapter: Sequences and Series

Important Formulas:

◆ Arithmetic Sequence (A.P.)

1. **General Term:** $T_n = a + (n - 1)d$
 2. **Sum of First n Terms:** $S_n = (n/2)[2a + (n - 1)d]$
 3. **Sum when last term known:** $S_n = (n/2)(a + l)$
 4. **If T_n is linear $\Rightarrow$ it's an A.P.**
-

◆ Geometric Sequence (G.P.)

5. **General Term:** $T_n = ar^{n-1}$
 6. **Sum of First n Terms:** $S_n = a(1 - r^n) / (1 - r)$ (if $r \neq 1$)
 7. **Infinite G.P. Sum:** $S = a / (1 - r)$ (if $|r| < 1$)
 8. **If T_n is exponential $\Rightarrow$ it's a G.P.**
-

◆ Harmonic Sequence (H.P.)

9. A sequence is H.P. if reciprocals form an A.P.
 10. **General Term of H.P.:** $T_n = 1 / [a + (n - 1)d]$
 11. **Nth term of H.P. = Reciprocal of A.P.'s nth term**
-

◆ Special Series

12. **Sum of first n natural numbers:** $S = n(n + 1)/2$
13. **Sum of squares:** $S = n(n + 1)(2n + 1)/6$

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14. **Sum of cubes:** $S = [n(n + 1)/2]^2$

15. **Sum of even numbers:** $n(n + 1)$

16. **Sum of odd numbers:** n^2

17. **If $T_n = a + br + cr^2 \Rightarrow$ Quadratic Sequence**

◆ Miscellaneous

18. **Arithmetic Mean (A.M.):** $A = (a + b)/2$

19. **Geometric Mean (G.M.):** $G = \sqrt[3]{(ab)}$

20. **Harmonic Mean (H.M.):** $H = 2ab / (a + b)$

21. **If A, G, H are in between a and b:** $A \geq G \geq H$

22. **If log terms in A.P., arguments are in G.P.**

23. **If exponents in A.P., terms are in G.P.**

24. **nth term from end of A.P. = $a + (N - n)d$**

25. **A sequence with common ratio r and $r = 1 \rightarrow$ constant sequence**

Identities:

- $A.M. \geq G.M. \geq H.M.$
 - **If three terms are in A.P.:** $b = (a + c)/2$
 - **If three terms are in G.P.:** $b^2 = ac$
 - **If three terms are in H.P.:** $2/b = 1/a + 1/c$
 - **For quadratic sequences: second difference is constant**
-

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Graphs Overview:

- A.P.: Graph is a straight line
 - G.P.: Exponential curve increasing/decreasing based on r
 - H.P.: Decreasing curve, asymptotic to axes
 - Graphs help visualize growth patterns of sequences
-

MCQ Tips / Tricks:

1. Identify type: A.P., G.P., or H.P. before applying formulas
 2. Use T_n formulas to find missing terms quickly
 3. Know when to apply infinite G.P. formula ($|r| < 1$)
 4. Plug-in small values like $n = 1, 2$ to test answers
 5. Use sum formulas to eliminate wrong choices fast
 6. For MCQs, check if series is arithmetic by subtracting terms
 7. Convert H.P. to A.P. by taking reciprocals
 8. Don't confuse term number (n) with term value (T_n)
 9. For nested series: simplify inner structure first
 10. Memorize formulas of common summations (n, n^2, n^3)
-

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Past NET MCQs Examples:

Q1:

Find 10th term of A.P. where $a = 3$ and $d = 2$

A. 21 B. 23 C. 20 D. 25



Correct: A $T_{10} = 3 + 9 \times 2 = 21$

Q2:

What is the sum of first 4 terms of G.P. if $a = 2$, $r = 3$?

A. 80 B. 60 C. 50 D. 62



Correct: B $S_4 = 2(1 - 3^4)/(1 - 3) = 2(1 - 81)/-2 = 2(-80)/-2 = 80$

Q3:

If 3, x, 27 are in G.P., find x:

A. 9 B. 15 C. 18 D. 21



Correct: A $x^2 = 3 \times 27 \Rightarrow x = \sqrt{81} = 9$

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Chapter: Probability and Statistics

Important Formulas:

◆ Probability Basics

1. **Probability of an Event:**

$$P(E) = \text{Number of favorable outcomes} / \text{Total outcomes}$$

2. $0 \leq P(E) \leq 1$ (Always between 0 and 1)

3. $P(\text{Sample Space}) = 1$

4. $P(A') = 1 - P(A)$ (Complement rule)

5. **Addition Rule (Mutually Exclusive):**

$$P(A \cup B) = P(A) + P(B)$$

6. **Addition Rule (Not Mutually Exclusive):**

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

7. **Multiplication Rule (Independent Events):**

$$P(A \cap B) = P(A) \times P(B)$$

8. **Conditional Probability:**

$$P(A | B) = P(A \cap B) / P(B)$$

9. **Probability of 'At least one':**

$$= 1 - P(\text{None})$$

10. **Probability of drawing cards, balls, digits:**

Use combinations where needed (nCr)

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◆ Statistics Basics

11. Mean (Average):

Mean = (Sum of all observations) / Total number

12. Median (Odd n):

Middle term

(Even n): Mean of two middle terms

13. Mode:

Most frequent number

14. Variance (σ^2):

$$\sigma^2 = \Sigma(x - \bar{x})^2 / n$$

15. Standard Deviation (σ):

$$\sigma = \sqrt{\text{Variance}}$$

16. Range:

= Largest value – Smallest value

17. Quartiles:

Q_1 (25%), Q_2 (Median), Q_3 (75%)

18. Interquartile Range (IQR):

$$= Q_3 - Q_1$$

19. Class Interval Midpoint:

$$= (\text{Lower limit} + \text{Upper limit})/2$$

20. Frequency Density:

$$= \text{Frequency} / \text{Class Width}$$

21. Cumulative Frequency:

Add frequencies progressively

22. Grouped Mean Formula:

$$\text{Mean} = \Sigma(f \times x) / \Sigma f$$

(where x = midpoints)

23. Empirical Rule (Normal Dist.):

68% within 1σ , 95% within 2σ , 99.7% within 3σ

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24. Skewness:

Right skewed $\Rightarrow$ Mean $>$ Median $>$ Mode

Left skewed $\Rightarrow$ Mean $<$ Median $<$ Mode

25. Histogram:

Graph for grouped frequency distribution

Identities:

- $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
- $P(A \cap B) = P(A) \times P(B)$ (if independent)
- $P(A | B) = P(A \cap B) / P(B)$
- $P(A') = 1 - P(A)$

Graphs Overview:

- **Histogram:** Rectangular bars for class intervals
- **Pie Chart:** Circular chart showing proportions
- **Line Graph:** Tracks changes over time
- **Bar Graph:** Compares different categories
- **Box Plot:** Displays median, quartiles, and outliers
- Visual tools help in quick estimation of mode, mean, etc.

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MCQ Tips / Tricks:

1. Read whether events are mutually exclusive or independent
 2. Use tree diagrams for conditional problems
 3. For 'at least one' problems, subtract from 1
 4. For data tables, calculate midpoints and apply formulas
 5. Double-check total frequency in grouped questions
 6. Remember that mean is affected by outliers, median is not
 7. Try simple plug-in values for concept-based questions
 8. In card/coin/dice problems, always list sample space if needed
 9. Use IQR and range for variability comparison
 10. Learn basic shapes of symmetric and skewed distributions
-

Past NET MCQs Examples:

Q1: What is the probability of getting an even number when a die is rolled?

A. $\frac{1}{2}$ B. $\frac{1}{3}$ C. $\frac{2}{3}$ D. 1

 **Correct: A** (3 even numbers out of 6: 2, 4, 6)

Q2: If $P(A) = 0.6$ and $P(B) = 0.3$ and A, B are independent, then $P(A \cap B) = ?$

A. 0.9 B. 0.18 C. 0.3 D. 0.6

 **Correct: B** ($0.6 \times 0.3 = 0.18$)

Q3: In a class of 20 students, average marks are 60. What's the total marks?

A. 1000 B. 1200 C. 1500 D. 900

 **Correct: B** (Mean $\times$ Number = $60 \times 20 = 1200$)

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Chapter: Vectors

Important Formulas:

◆ Basics

1. **Vector Notation:** $\mathbf{A} = a_1\mathbf{i} + a_2\mathbf{j} + a_3\mathbf{k}$
2. **Magnitude (Length):** $|\mathbf{A}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$
3. **Unit Vector:** $\hat{\mathbf{a}} = \mathbf{A} / |\mathbf{A}|$
4. **Zero Vector:** $\mathbf{O} = 0\mathbf{i} + 0\mathbf{j} + 0\mathbf{k}$
5. **Position Vector of point P(x, y, z):** $\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$

◆ Operations

6. **Addition:** $\mathbf{A} + \mathbf{B} = (a_1 + b_1)\mathbf{i} + (a_2 + b_2)\mathbf{j} + (a_3 + b_3)\mathbf{k}$
7. **Subtraction:** $\mathbf{A} - \mathbf{B} = (a_1 - b_1)\mathbf{i} + (a_2 - b_2)\mathbf{j} + (a_3 - b_3)\mathbf{k}$
8. **Scalar Multiplication:** $k\mathbf{A} = (ka_1)\mathbf{i} + (ka_2)\mathbf{j} + (ka_3)\mathbf{k}$
9. **Negative of a vector:** $-\mathbf{A} = (-a_1)\mathbf{i} + (-a_2)\mathbf{j} + (-a_3)\mathbf{k}$

◆ Dot Product (Scalar Product)

10. $\mathbf{A} \cdot \mathbf{B} = a_1b_1 + a_2b_2 + a_3b_3$
11. Also: $\mathbf{A} \cdot \mathbf{B} = |\mathbf{A}||\mathbf{B}|\cos\theta$
12. If $\mathbf{A} \perp \mathbf{B} \Rightarrow \mathbf{A} \cdot \mathbf{B} = 0$
13. If $\mathbf{A} \parallel \mathbf{B} \Rightarrow \mathbf{A} \times \mathbf{B} = \mathbf{0}$
14. **Angle Between Vectors:**
 $\cos\theta = (\mathbf{A} \cdot \mathbf{B}) / (|\mathbf{A}||\mathbf{B}|)$

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◆ Cross Product (Vector Product)

15. $\mathbf{A} \times \mathbf{B}$ = Determinant method:

$\mathbf{i} \quad \mathbf{j} \quad \mathbf{k}$

$a_1 \quad a_2 \quad a_3$

$b_1 \quad b_2 \quad b_3$

16. **Magnitude:** $|\mathbf{A} \times \mathbf{B}| = |\mathbf{A}||\mathbf{B}|\sin\theta$

17. **Direction:** Perpendicular to both $\mathbf{A}$ and $\mathbf{B}$

18. $\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$ (Anti-commutative)

◆ Applications

19. **Work** = Force $\cdot$ Displacement = $\mathbf{F} \cdot \mathbf{d}$

20. **Area of Parallelogram** = $|\mathbf{A} \times \mathbf{B}|$

21. **Area of Triangle** = $(1/2)|\mathbf{A} \times \mathbf{B}|$

22. **Projection of $\mathbf{B}$ on $\mathbf{A}$** = $(\mathbf{A} \cdot \mathbf{B}) / |\mathbf{A}|$

23. **Direction Cosines:**

$$l = a/|\mathbf{A}|, m = b/|\mathbf{A}|, n = c/|\mathbf{A}|$$

◆ More Properties

$$24. |\mathbf{A} + \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 + 2\mathbf{A} \cdot \mathbf{B}$$

$$25. |\mathbf{A} - \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 - 2\mathbf{A} \cdot \mathbf{B}$$

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Identities:

- $\mathbf{A} \cdot \mathbf{B} = |\mathbf{A}||\mathbf{B}|\cos\theta$
 - $\mathbf{A} \times \mathbf{B} = |\mathbf{A}||\mathbf{B}|\sin\theta \cdot \hat{\mathbf{n}}$
 - $\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$
 - $\mathbf{A} \cdot \mathbf{A} = |\mathbf{A}|^2$
 - $\mathbf{A} \times \mathbf{A} = \mathbf{0}$
-

Graphs Overview:

- **Vectors shown as arrows** in 2D or 3D
 - Direction and magnitude visually represented
 - Right-angle between vectors $\Rightarrow$ dot product = 0
 - Use diagrams to show triangle law of addition, parallelograms
-

MCQ Tips / Tricks :

1. If vectors are perpendicular $\Rightarrow$ dot product = 0
 2. If vectors are parallel $\Rightarrow$ cross product = 0
 3. Use determinant to compute cross product quickly
 4. Plug small values to test multiple-choice options
 5. Use $|\mathbf{A} + \mathbf{B}|^2$ trick when needed
 6. Visualize vector direction for 3D motion problems
 7. Remember angle-related rules: dot (cos), cross (sin)
 8. Cross product results in vector $\perp$ to both operands
 9. Apply vector formulas in physics-style word problems
-

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✓ Past NET MCQs Examples Q1:

If $\mathbf{A} = 2\mathbf{i} + 3\mathbf{j}$, $\mathbf{B} = \mathbf{i} - \mathbf{j}$, then $\mathbf{A} \cdot \mathbf{B} = ?$

A. 5 B. 1 C. -1 D. 2

■ **Correct: B**

$$\mathbf{A} \cdot \mathbf{B} = 2 \times 1 + 3 \times (-1) = 2 - 3 = -1$$

Q2:

Magnitude of vector $\mathbf{A} = 3\mathbf{i} + 4\mathbf{j}$?

A. 5 B. 7 C. 12 D. $\sqrt{25}$

■ **Correct: A**

$$|\mathbf{A}| = \sqrt{3^2 + 4^2} = 5$$

Q3:

If $\mathbf{A} \parallel \mathbf{B}$, then which is true?

A. $\mathbf{A} \cdot \mathbf{B} = 0$ B. $\mathbf{A} \times \mathbf{B} = 0$ C. $|\mathbf{A} + \mathbf{B}| = 0$ D. None

■ **Correct: B**

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Chapter: Application of Derivatives

Important Formulas:

◆ Rate of Change

1. If $y=f(x)$, then
 $\frac{dy}{dx}$ = rate of change of y w.r.t. x
 2. Velocity = $\frac{dx}{dt}$
 3. Acceleration = $\frac{d^2x}{dt^2}$
 4. Growth/Decay rate = $\frac{dN}{dt}$ (where N = population/quantity)
-

◆ Maxima and Minima

5. If $f'(x) = 0$ and $f''(x) < 0 \Rightarrow$ **Maximum**
 6. If $f'(x) = 0$ and $f''(x) > 0 \Rightarrow$ **Minimum**
 7. **Critical points:** $f'(x) = 0$ or $f'(x)$ undefined
 8. **Point of Inflection:** $f''(x) = 0$ and sign changes
-

◆ Applications

9. **Increasing function:** $f'(x) > 0$
10. **Decreasing function:** $f'(x) < 0$
11. For **maximum area/volume**, use $f'(x) = 0$ and test
12. **Optimization Problems:** Apply constraints, form function, use derivative
13. **Cost/Profit/Revenue:** Derivatives used for marginal analysis
14. **Marginal Cost** = $\frac{dC}{dx}$, **Marginal Revenue** = $\frac{dR}{dx}$

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15. If $MR > MC \Rightarrow$ Increase output

16. If $MR < MC \Rightarrow$ Decrease output

17. If $MR = MC \Rightarrow$ Optimal production level

◆ Other Applications

18. **Tangents and Normals:**

Slope of tangent = dy/dx

Slope of normal = $-1 / (dy/dx)$

19. **Angle between curves** using slopes

20. **Curvature:** rate at which curve bends

21. **Differentiability Check:** Left-hand = Right-hand derivative

22. **Linear Approximation:** $f(x + h) \approx f(x) + h \cdot f'(x)$

◆ Second Derivative Test

23. If $f''(x) > 0 \Rightarrow$ Local Min

24. If $f''(x) < 0 \Rightarrow$ Local Max

25. If $f''(x) = 0 \Rightarrow$ Use higher-order derivatives or other tests

Identities / Concepts:

- **First Derivative Test:** Analyze sign of $f'(x)$ around critical points
 - **Second Derivative Test:** $f''(x)$ gives nature of turning point
 - **Slope of tangent** at point = derivative at that point
 - **Optimization** always uses $f'(x) = 0$ condition
-

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Graphs Overview:

- **Maxima/Minima:** Peaks and valleys of graph
 - **Inflection point:** Change in concavity
 - **Slope** at a point = steepness of curve = dy/dx
 - Use graph to visualize increase/decrease behavior
 - Useful for interpreting practical real-world questions
-

MCQ Tips / Tricks:

1. Always check sign of first and second derivatives
 2. For MCQs: plug values around critical points
 3. Watch for "greatest" or "least" in word problems → optimization
 4. If derivative is zero $\Rightarrow$ possible turning point
 5. Understand function behavior before choosing option
 6. Velocity = derivative of position $\Rightarrow$ useful in motion problems
 7. Don't forget units (e.g., m/s, kg/hr) if in word problems
 8. Practice geometric interpretation (tangent = slope = dy/dx)
 9. Read word problems carefully – what are you maximizing or minimizing?
 10. In economics-based MCQs, look for $MR = MC$ condition
-

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Past NET MCQs Examples:

Q1:

If $f(x) = x^3 - 3x^2 + 1$, find $f'(x)$

A. $3x^2 - 6x$ B. $2x - 3$ C. $x^2 - 6x$ D. $3x^2 - x$

 **Correct: A**

Q2:

What is the slope of the tangent to $y = x^2$ at $x = 2$?

A. 2 B. 4 C. 6 D. 8

 **Correct: B** ($dy/dx = 2x \Rightarrow$ at $x = 2 \Rightarrow 2 \times 2 = 4$)

Q3:

At what x is the function $f(x) = -x^2 + 4x + 5$ maximum?

A. $x = 2$ B. $x = -2$ C. $x = 1$ D. $x = 3$

 **Correct: A**

(Vertex of quadratic $ax^2 + bx + c \Rightarrow x = -b/2a = -4/-2 = 2$)
