JEE MAINS & ADVANCED
Formula Sheet: Basic Mathematics

1   Laws of Indices

Power Rules

Fundamental properties of exponents for algebraic manipulation:

- $a^m \times a^n = a^{m+n}$
- $\frac{a^m}{a^n} = a^{m-n}$
- $(a^m)^n = a^{mn}$
- $(ab)^n = a^n \cdot b^n$
- $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

2   Surds and Radicals

Roots and Rationalization

- $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$
- $\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$
- $(\sqrt{a} + \sqrt{b})^2 = a + 2\sqrt{ab} + b$
- $(\sqrt{a} - \sqrt{b})^2 = a - 2\sqrt{ab} + b$

3   Logarithms

Logarithmic Identities

Essential for solving exponential equations and calculus:

- $\log(ab) = \log a + \log b$
- $\log\left(\frac{a}{b}\right) = \log a - \log b$
- $\log(a^n) = n \log a$
- $\log_b a = \frac{\log a}{\log b}$ (Base Change Formula)

4   Equations

4.1   Linear Equations

General form: $ax + b = 0$.
Solution: $x = -\frac{b}{a}$ $(a \neq 0)$

4.2   Quadratic Equations

General form: $ax^2 + bx + c = 0$

Quadratic Formula & Discriminant

Roots are given by:

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

Discriminant $(D) = b^2 - 4ac$

Nature of Roots:

- $D > 0 \implies$ Real and Distinct

- $D = 0 \implies$ Real and Equal

- $D < 0 \implies$ Complex Conjugates

5   Factorization Formulas

Algebraic Identities

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

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

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

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

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

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6   Sets and Logic

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Set Theory

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

- Complement: $A' = U - A$ (where U is the Universal Set)

- **De Morgan's Laws:**
  1. $(A \cup B)' = A' \cap B'$
  2. $(A \cap B)' = A' \cup B'$

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7   Relations and Functions

- **Function:** A mapping where every input corresponds to exactly one output.

- **Domain:** Set of all valid inputs.

- **Range:** Set of all possible outputs.