

NUMBER BASES



□ Definition:

- A number base refers to the system used to represent numbers. It is determined by the number of digits available, including zero. For instance, the decimal system (base 10) uses digits 0 to 9, while the binary system (base 2) uses only 0 and 1.

□ Common Number Bases:

- **Base 2 (Binary):** Used in computing; digits are 0 and 1.
- **Base 8 (Octal):** Digits are 0 to 7.
- **Base 10 (Decimal):** The most commonly used system; digits are 0 to 9.
- **Base 16 (Hexadecimal):** Digits are 0 to 9 and letters A to F, where A = 10, B = 11 ... F = 15.

□ Conversion Between Bases:

● From Base 10 to Other Bases:

- Divide the number by the base and record the remainders.
- Write the remainders in reverse order.

● From Other Bases to Base 10:

- Multiply each digit by the base raised to the power of its position (starting from 0, right to left).
- Sum the results.

● Example 1: Convert 45_{10} to base 2.

- $45 \div 2 = 22, R1$
- $22 \div 2 = 11, R0$
- $11 \div 2 = 5, R1$
- $5 \div 2 = 2, R1$
- $2 \div 2 = 1, R0$
- $1 \div 2 = 0, R1$

Answer: $45_{10} = 101101_2$.

□ **Applications of Number Bases:**

- Binary is used in computer systems.
- Octal and hexadecimal simplify binary coding.

FRACTIONS, DECIMALS, APPROXIMATION, AND PERCENTAGES

□ **Fractions:**

- A fraction represents a part of a whole.
- **Proper Fraction:** Numerator < Denominator (e.g. $\frac{5}{8}$).
- **Improper Fraction:** Numerator > Denominator (e.g. $\frac{7}{4}$).
- **Mixed Numbers:** Combines a whole number and a fraction (e.g. $2\frac{1}{3}$).

□ **Decimals:**

- A decimal is a fraction expressed in base 10.
- **Example:** $0.25 = \frac{25}{100}$.
- **Conversion:**
 - **Fraction to Decimal:** Divide the numerator by the denominator.
 - **Decimal to Fraction:** Place the decimal over the appropriate power of 10 and simplify.

□ **Approximation:**

- Rounding Off: Adjusting numbers to a desired degree of accuracy.
- **Example:** Round 5.678 to 2 decimal places → 5.68.
- **Significant Figures:** Retain a set number of meaningful digits.

□ **Percentage:**

- A percentage is a fraction expressed with a denominator of 100.
- **Formula:**

$$\text{Percentage} = \frac{\text{Part}}{\text{Whole}} \times 100$$

- **Example:** What is 20% of 50?

$$\frac{20}{100} \times 50 = 10.$$

INDICES, LOGARITHMS, AND SURDS

□ Indices (Powers):

- Used to express repeated multiplication.
- **Example:** $2^3 = 2 \times 2 \times 2 = 8$.

□ Laws of Indices:

- $a^m \times a^n = a^{m+n}$.
- $a^m / a^n = a^{m-n}$.
- $(a^m)^n = a^{mn}$.
- $a^0 = 1$

□ Logarithms:

- The logarithm of a number is the power to which a base must be raised to obtain that number.
- **Formula:** $\log_b (a) = c \rightarrow b^c = a$

□ Surds:

- A surd is an irrational root that cannot be simplified into a whole number.
- **Example:** $\sqrt{2}, \sqrt{5}, \sqrt[3]{7}$
- **Simplifying Surds:**
 - $\sqrt{12} = \sqrt{4 \times 3} = 2\sqrt{3}$
 - $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$

SETS

□ Definition:

- A set is a collection of distinct objects, called elements.

□ Types of Sets:

- **Finite Set:** Has a fixed number of elements (e.g. $A = 1, 2, 3$).
- **Infinite Set:** Has unlimited elements (e.g., the set of natural numbers).
- **Empty Set (Null Set):** Contains no elements (e.g. $\emptyset$).
- **Universal Set:** Contains all possible elements under consideration.

□ Set Operations:

- **Union (U):** Combines elements of two sets.
$$A \cup B = \{x \mid x \in A \text{ or } x \in B\}$$
- **Intersection ($\cap$):** Common elements in two sets.
$$A \cap B = \{x \mid x \in A \text{ and } x \in B\}$$
- **Difference ($-$):** Elements in one set but not the other.
$$A - B = \{x \mid x \in A \text{ and } x \notin B\}$$

□ Venn Diagrams:

- A diagrammatic representation of sets and their relationships.
- **Example:**
Let $A = 1, 2, 3$ and $B = 3, 4, 5$:
 - $A \cup B = 1, 2, 3, 4, 5$
 - $A \cap B = 3$
 - $A - B = 1, 2$

□ Applications of Sets:

- Used in probability, data analysis, and logic.