

GROUPS, RINGS AND FIELDS

These are basic notions of abstract algebra, which is widely used in cryptography.

A **group** G , sometimes denoted by $\{G, \bullet\}$, is a set of elements with a binary operation, denoted by $\bullet$, that associates to each ordered pair (a,b) of elements in G an element $(a \bullet b)$ in G , such that the following axioms are obeyed:

(A1) Closure: If a and b belong to G , then $a \bullet b$ is also in G

(A2) Associative: $a \bullet (b \bullet c) = (a \bullet b) \bullet c$ for all a,b,c in G

(A3) Identity element: There is an element e in G such that $a \bullet e = e \bullet a = a$ for all a in G

(A4) Inverse element: For each a in G there is an element a' in G such that $a \bullet a' = a' \bullet a = e$

Example: set S_N of permutations on the set $\{1,2,\dots,N\}$ with operation $\bullet$ - composition of permutations is a group with $e = (1,2,\dots,N)$. For $N=3$, $(123) \bullet (321) = (321)$; $(213) \bullet (132) = (312)$

If a group has a finite number of elements, it is referred to as a **finite group**, and the **order** of the group is equal to the number of elements in the group. Otherwise, the group is **infinite group**.

A group is said to be **abelian** if it satisfies the following additional condition:

(A5) Commutative: $a \bullet b = b \bullet a$ for all a,b in G

The set of integers (positive, negative, and 0) under addition is an abelian group. The set of real numbers under multiplication is an abelian group.

The set S_N of permutations is not an abelian group.

When the group operation is addition, the identity element is 0; the inverse element of a

is $-a$; and the subtraction is defined as: $a-b = a+(-b)$.

Exponentiation within a group is defined as repeated application of the group operation, so that $a^3 = a \bullet a \bullet a$. We define also $a^0 = e$, the **identity element**, and $a^{-1} = (a')^*$, where a' is **inverse element** for a . A group G is **cyclic** if every element of G is a power a^k (k - integer) of a fixed element $a \in G$. The element a is said to **generate** the group G , or to be a **generator** of G . A cyclic group is always abelian, and may be finite or infinite.

Basic Algebra Groups Rings And Fields

WJ Hussar



Basic Algebra Groups Rings And Fields:

Reviewing **Basic Algebra Groups Rings And Fields**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is actually astonishing. Within the pages of "**Basic Algebra Groups Rings And Fields**," an enthralling opus penned by a very acclaimed wordsmith, readers attempt an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve in to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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