1. Laws of Algebra of Sets.

(1) **Idempotent laws:** For any set A, we have

(i) $A \cup A = A$ (ii) $A \cap A = A$

(2) **Identity laws:** For any set A, we have

(i) $A \cup \phi = A$ (ii) $A \cap U = A$

i.e. ϕ and U are identity elements for union and intersection respectively.

(3) **Commutative laws:** For any two sets A and B, we have

(i) $A \cup B = B \cup A$ (ii) $A \cap B = B \cap A$ (iii) $A \Delta B = B \Delta A$

i.e. union, intersection and symmetric difference of two sets are commutative.

(iv) $A - B \neq B - A$ (iv) $A \times B \neq B \times A$

i.e., difference and Cartesian product of two sets are not commutative

(4) **Associative laws:** If A, B and C are any three sets, then

(i) $(A \cup B) \cup C = A \cup (B \cup C)$ (ii) $A \cap (B \cap C) = (A \cap B) \cap C$ (iii) $(A \Delta B) \Delta C = A \Delta (B \Delta C)$

i.e., union, intersection and symmetric difference of two sets are associative.

(iv) $(A - B) - C \neq A - (B - C)$ (v) $(A \times B) \times C \neq A \times (B \times C)$

i.e., difference and Cartesian product of two sets are not associative.

(5) **Distributive law:** If A, B and C are any three sets, then

(i) $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ (ii) $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$

i.e. union and intersection are distributive over intersection and union respectively.

(iii) $A \times (B \cap C) = (A \times B) \cap (A \times C)$ (iv) $A \times (B \cup C) = (A \times B) \cup (A \times C)$ (v) $A \times (B - C) = (A \times B) - (A \times C)$

(6) **De-Morgan's law:** If A and B are any two sets, then

(i) $(A \cup B)' = A' \cap B'$ (ii) $(A \cap B)' = A' \cup B'$

(iii) $A - (B \cup C) = (A - B) \cap (A - C)$ (iv) $A - (B \cap C) = (A - B) \cup (A - C)$

Note: **Theorem 1:** If A and B are any two sets, then

(i) $A - B = A \cap B'$ (ii) $B - A = B \cap A'$

(iii) $A - B = A \Leftrightarrow A \cap B = \phi$ (iv) $(A - B) \cup B = A \cup B$

(v) $(A - B) \cap B = \phi$ (vi) $A \subseteq B \Leftrightarrow B' \subseteq A'$

(viii) $(A - B) \cup (B - A) = (A \cup B) - (A \cap B)$

Theorem 2: If A, B and C are any three sets, then

(i) $A - (B \cap C) = (A - B) \cup (A - C)$ (ii) $A - (B \cup C) = (A - B) \cap (A - C)$

(iii) $A \cap (B - C) = (A \cap B) - (A \cap C)$ (iv) $A \cap (B \Delta C) = (A \cap B) \Delta (A \cap C)$