15/10/21 Friday

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**Course Code: MAT133**
**Semester: I**

## DISCRETE MATHEMATICS

**Course Objective:**

This course will help the learner to understand Boolean Algebra and basic properties of Boolean Algebra, various concepts in Differential and Integral calculus, Algebraic structures like Groups, Rings, Fields and construct proofs by Mathematical Induction.

**UNIT - I** **10 Periods**

**Boolean algebra**: Introduction of Boolean Algebra - Truth Table - Basic Logic Gates - Basic Postulates of Boolean Algebra - Principle of Duality - Canonical Form - Karnaugh Map.

**UNIT - II** **10 Periods**

**Calculus**: Differential Calculus – Limits, Continuity, Geometrical interpretation of the derivative, Integral Calculus - Applications of Double and Triple Integrals, to calculate Volume of solids.

**UNIT - III** **15 Periods**

**Abstract algebra: Sets-** Basic Set Operations-Cartesian Product and Power sets – Relations, functions and their properties, **Groups** – Groups, Abelian groups, Subgroups, Cyclic groups, Cosets, Lagrange's theorem; **Introduction to Rings and Fields:** Basic definitions and concepts.

**UNIT - IV** **10 Periods**

**Combinatorics:** Basic Counting principles - Balls and Pins Problems - Pigeonhole Principle- Generating Functions - Recurrence Relations - **Proof Techniques** - Principle of Mathematical Induction

**TEXTBOOKS**


1. T Veerarajan, *Discrete Mathematics*, Tata Mc-Graw Hill Education, 2008.
2. Morris Mano M. *Digital Logic & Computer Design,* Pearson Education, Tenth Imprint, 2008.
3. Grewal B.S.*Higher Engineering Mathematics,* Khanna Publication, Delhi, Forty Fourth Edition, 2015.


**REFERENCES**

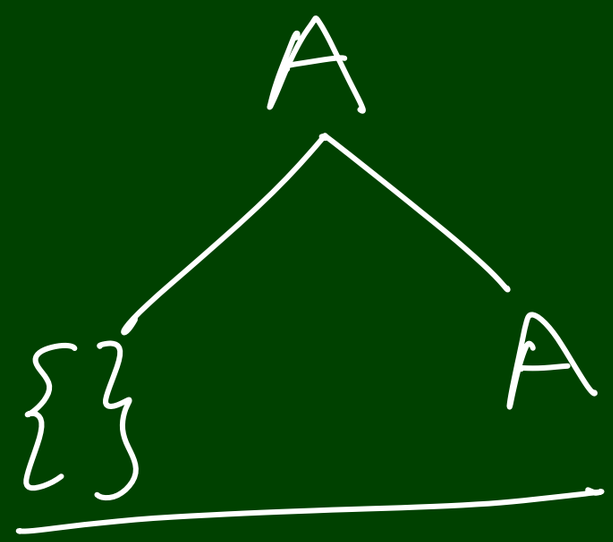

1. Joseph A. Gallian, *Contemporary Abstract Algebra,* Brooks/Cole CENGAGE Learning, 2013.
2. HersteinI.N.*Topics in Algebra,* John Wiley and Sons, Second Edition,2006.
3. Peter V.O'Neil, *Advanced Engineering Mathematics*, Thomson Learning, Seventh Edition, 2012.
4. Greenberg M. D, *Advanced Engineering Mathematics*, Pearson Education, Second Edition, 2002.
5. Wartikar P.N, Wartikar J.N. Textbook of *Applied Mathematics*, Volume I and II, Vidyarthi Prakashan, 2010.


## Basic Concepts :-

① **Set :-** A collection of well-defined objects.

② **Subset :-** Let A and B be any two sets. Then A is said to be a subset of B if each and every element of A is an element of B.

$A \subseteq B$ $A \subset B$




Improper of Trivial

③ Cardinality :- $|A|$ & $n(A)$ of $O(A)$

$A = \{a, e, i, o, u\}$

$|A| = 5$

④ Empty set :- $|A| = 0 \iff A = \varphi$

⑤ Singleton set :- If its cardinality is one.

⑥ Power set :- Let A be a set. Then the power set of A is denoted by $P(A)$ of $S(A)$ of $2^A$ and it is defined as the set of all subsets of A.

$A = \{a, b\} \longrightarrow |A| = 2$

$P(A) = \{\phi, \{a\}, \{b\}, \{a, b\}\} \rightarrow |P(A)| = 4$

$A = \{a, b, c\} \longrightarrow |A| = 3$

$P(A) = \{\phi, \{a\}, \{b\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$

$\longrightarrow |P(A)| = 8$

$|P(A)| = 2^{|A|}$ ($2^0 = 1$)

$A = \phi \longrightarrow |A| = 0$

$P(A) = \{\phi\} \rightarrow |P(A)| = 1$

⑦ Union :- $A \cup B = \{x \in E \mid \underbrace{x \in A \text{ or } x \in B}_{x \in A \text{ or } x \in B}\}$

$A = \{1, 2, 3\}$ ; $B = \{2, 4, 6\}$

$A \cup B = \{1, 2, 3, 4, 6\}$

⑧ Intersection :- $A \cap B = \{x \in E \mid x \in A \text{ and } x \in B\}$

$A = \{1, 2, 3\}$ $B = \{2, 4, 6\}$

$A \cap B = \{2\}$

$A = \{1, 3, 5\}$ $B = \{2, 4, 6\} \Rightarrow A \cap B = \phi$

## (9) Relative Complement :-

$$A - B = \{x \in E \mid x \in A \text{ and } x \notin B\}$$

$$B - A = \{x \in E \mid x \in B \text{ and } x \notin A\}$$

$A - B$ → Relative Complement of B w.r.t. A

$B - A$ → Relative Complement of A w.r.t. B

## (10) Symmetric Difference :-

$$A \triangle B = (A - B) \cup (B - A)$$

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

$$A = \{1, 2, 3, 4, 5\} \; ; \; B = \{3, 4, 6\}$$

$$A - B = \{1, 2, 5\} \qquad B - A = \{6\}$$

$$A \triangle B = \{1, 2, 5, 6\}$$

## (11) Complement :- $\overline{A}$ or $A^c$ or $A'$

$$A' = \{x \in E \mid x \notin A\}$$

$$E = \{1, 2, 3, \ldots, 25\}$$

$$A = \{1, 2, 3, \ldots, 15\}$$

$$A' = \{16, 17, \ldots, 25\}$$

(12) Cartesian product :- $A \times B$

$$A \times B = \{(a,b) \mid a \in A \text{ and } b \in B\}$$

$A = \{1, 2, 3\}$ $B = \{a, b\}$ — $|B| = 2$

$|A| = 3$

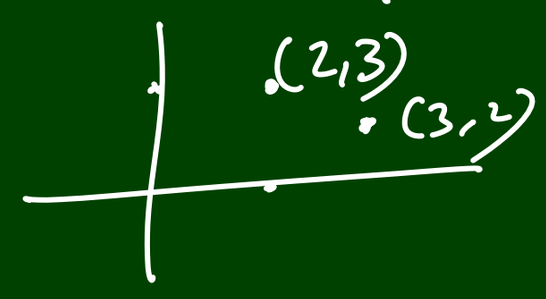
$A \times B = \{(1,a), (1,b), (2,a), (2,b), (3,a), (3,b)\}$ — $|A \times B| = 6$

$B \times A = \{(a,1), (a,2), (a,3), (b,1), (b,2), (b,3)\}$ — $|B \times A| = 6$

$(1,a) \neq (a,1)$

$A \times B \neq B \times A$

$A = B$ $\quad$ $A \times B = B \times A$




(2) $|A \times B| = |A|\,|B|$

Relations

Any subset of $A \times B$ is a relation from A to B

$|A| = m$ $\quad$ $|B| = n$

$2^{mn}$ $\quad$ $2^{|A \times B|}$ $\quad$ $2^{m\,n}$ $\quad$ $2^{|A|\,|B|}$

$\phi \subseteq A \times B$ — VOID

$A \times B \subseteq A \times B$ — UNIVERSAL

Any subset of $A \times A$ is a relation on A

$A \times A \times A \times \cdots$ n times

$A = \{0, 1\}$ $\quad A \times A = \{(0,0), (0,1), (1,0), (1,1)\}$

$A \times A \times A = \{(0,0,0), (0,0,1), (0,1,0), (0,1,1), (1,0,0), (1,0,1), (1,1,0), (1,1,1)\}$

$A \times A \times \cdots$ n times $= \{(0,0,\cdots,0), (0,0,\cdots 1), \cdots (1,1,1,\cdots 1)\}$

Any subset of $A \times A \times A \times \cdots$ n times is called as n - ary relation on A.

$\underline{n=2} \rightarrow$ binary

$\underline{n=3} \rightarrow$ ternary

Relations

R on A

- Reflexive
- Symmetric
- Transitive
- Anti-Symmetric
- Asymmetric
- Irreflexive