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**MCA**  
**(SEM I) THEORY EXAMINATION 2021-22**  
**DISCRETE MATHEMATICS**

**Time: 3 Hours****Total Marks: 100****Note: 1.** Attempt all Sections. All the symbols have their usual meaning.**SECTION A****1. Attempt all questions in brief.**

Qno.	Question	Marks	CO
a.	What is the cardinality of the set? Find the cardinality of the set $\{1, \{2, \phi, \{\phi\}\}, \{\phi\}\}$ .	2	1
b.	Let the two following functions be defined on set of real numbers be as: $f(x) = 2x+3$ and $g(x) = x^2+1$ . Find the $(f \circ g)(x)$ .	2	1
c.	Define the well-ordered set? Give an example of well-ordered set.	2	2
d.	Draw the Hasse diagram of the lattice of $(D_6,  )$ .	2	2
e.	Define Tautology and Contradiction.	2	3
f.	Discuss the truth table of $p \leftrightarrow q$ .	2	3
g.	What is the generator of a cyclic group?	2	4
h.	Find the order of each element in the group $(\{1, -1\}, \cdot)$ .	2	4
i.	Find the number of handshakes in party of 12 people, where each two of them shake hands with each other.	2	5
j.	Discuss the pigeonhole principle?	2	5

**SECTION B****2. Attempt any three of the following:**

Qno.	Question	Marks	CO
a.	Prove that the relation $(x, y) \in R$ , if $x \geq y$ defined on the set of positive integers is a partial order relation.	10	1
b.	If $B = \{1, 3, 5, 15\}$ , then show that $(B, +, \cdot, ')$ is a Boolean Algebra, where $a + b = \text{lcm}(a, b)$ , $a \cdot b = \text{gcd}(a, b)$ and $a' = \frac{15}{a}$ .	10	2
c.	(i) Prove that conditional proposition and its contrapositive are equivalent, i.e. $(p \rightarrow q) \equiv \sim q \rightarrow \sim p$ . (ii) Prove the equivalence: $(p \rightarrow q) \rightarrow q \equiv p \vee q$	10	3
d.	Show that set $\mathbb{Z}_6 = \{0, 1, 2, 3, 4, 5\}$ forms a group with respect to addition modulo 6.	10	4
e.	(i) State all PEANO's axioms. (ii) In how many ways, can 7 boys and 5 girls be seated in a row, so that no two girls may sit together?	10	5

**SECTION C****3. Attempt any one part of the following:**

Qno.	Question	Marks	CO
a.	In a survey of 60 people, it was found that 25 eat <b>Apple</b> , 26 eat <b>Orange</b> and 26 eat <b>Banana</b> fruit. Also 9 eat both <b>Apple</b> and <b>Banana</b> , 11 eat both <b>Orange</b> and <b>Apple</b> , and 8 eat both <b>Orange</b> and <b>Banana</b> . 8 eat no fruit at all. Then determine i. the number of people who eat all three fruit. ii. the number of people who eat exactly two fruit.	10	1



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	iii. the number of people who eat exactly one fruit		
b.	State and Prove De Morgan's laws for set theory.	10	1

**4. Attempt any one part of the following:**

Qno.	Question	Marks	CO
a.	(i) Write the definition of the maximal, minimal, greatest and least element of a Poset. (ii) If $S = \{10, 11, 12\}$ . Determine the power set of S. Draw the Hasse diagram of Poset $(P(S), \subseteq)$ . (iii) Find the maximal, minimal, greatest and least element of the Poset in Part (ii).	10	2
b.	i) Determine the DNF of Boolean expression $f(x, y, z) = x + y' \cdot z$ ii) Simplify the following Boolean expression using K-Map method: $A'B'C' + A'B'C + A'BC + A'BC' + AB'C + ABC$ .	10	2

**5. Attempt any one part of the following:**

Qno.	Question	Marks	CO
a.	(i) Given the value of $p \rightarrow q$ is false, determine the value of $(\sim p \vee \sim q) \rightarrow q$ . (ii) Prove the equivalence: $(p \rightarrow q) \rightarrow q \equiv p \vee q$ .	10	3
b.	State and Prove De Morgan's laws for propositions using truth table.	10	3

**6. Attempt any one part of the following:**

Qno.	Question	Marks	CO
a.	Show that set of all integers $\mathbb{Z}$ forms a group with respect to binary operation $*$ defined as $a * b = a + b + 1$ , where $a, b \in \mathbb{Z}$ .	10	4
b.	(i) Define Ring and Field. Give an example of a Ring and a Field. (ii) Prove that every cyclic group is abelian.	10	4

**7. Attempt any one part of the following:**

Qno.	Question	Marks	CO
a.	State Mathematical Induction. Using the Mathematical Induction, show that $1^2 + 2^2 + 3^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}$ , $n \geq 1$ .	10	5
b.	Use generating functions to solve the recurrence relation, $a_n - 9a_{n-1} + 20a_{n-2} = 0$ where $a_0 = -3$ and $a_1 = -10$ .	10	5