

MID-SEMESTER EXAMINATION, November-2025
DISCRETE MATHEMATICS (MA 3001)

Program: MCA
Full Marks: 30

Semester: 1st
Time: 2 Hours

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
Understand and apply rules of logic to distinguish between valid and invalid Arguments and use them to prove mathematical statements.	L2, L3	1(a), 1(b), 1(c), 2(a), 2(b), 2(c)	12
Comprehend sets, their various operations and use them to analyze functions and its various concepts as well as study sequences and summations.	L3, L4	3(a), 3(b), 3(c), 4(a), 4(b), 4(c)	12
Analyze the searching and sorting algorithms and use the growth of functions to study the time complexity of algorithms as well as apply some of the important concepts of number theory to divisibility and modular arithmetic, integer representation of algorithms, congruence and cryptography.	L3, L4, L5	5(a), 5(b) 5(c)	6
Construct proofs by mathematical induction and formulate recursive definitions and develop structural induction.	L3, L4, L5	-	-
Apply different counting techniques to solve various problems.	L4, L5	-	-
Implement relations and their properties to analyze equivalence relations and partial orderings.	L3, L4, L5	-	-

*Bloom's taxonomy levels: Remembering (L1), Understanding (L2), Application (L3), Analysis (L4), Evaluation (L5), Creation (L6)

Answer all questions. Each question carries equal mark.

1. (a) Write the converse, inverse and contrapositive of the statement: 2

"If an integer is divisible by 6, then it is divisible by 3."

- (b) Write the negation of the following statement so that no negation symbol appears to the left of a quantifiers: 2

"For every real number x , if $x > 2$, then $x^2 > 4$."

- (c) Use the proof by contraposition to prove that: 2
"If n is an integer and $3n + 2$ is even, then n is even."

2. (a) Determine whether the statement 2

$$\sim(p \vee q) \vee (\sim p \wedge r) \rightarrow \sim q$$

is a tautology, contradiction or contingency using truth table.

- (b) Use rules of inference to show that the following premises imply the conclusion: "If it is raining, I will stay home." "If I stay home, I will finish my assignment." "It is raining." Therefore, "I will finish my assignment." 2

- (c) Are the statements $\forall x(P(x) \vee Q(x))$ and $\forall x(P(x)) \vee \forall x(Q(x))$ are logically equivalent? Justify your answer with an explanation or counter example. 2

3. (a) Prove the set identity using set builder form 2

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

- (b) Let the function $g: \mathbb{R} \rightarrow \mathbb{R}$ be defined by $g(x) = x^3 - x$. Determine whether g is (i) One-to-One (Injective) (ii) Onto (Surjective). Justify your answers. 2

- (c) Let $f(x) = |x - 2|$ and $g(x) = x^2$. Find $(f \circ g)(x)$ and $(g \circ f)(x)$. 2

4. (a) Evaluate the double summation: 2

$$\sum_{i=1}^3 \sum_{j=0}^2 (2i + 3j)$$

- (b) Find the Boolean product $A \odot B$, where 2

$$A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$

- (c) Give a recursive definition of the sequence $\{a_n\}$, $n = 1, 2, 3, \dots$, if $a_n = 5n - 2$. 2

5. (a) Describe an algorithm for determining whether a string of n characters is a palindrome. 2

- (b) List all the steps used to search for 9 in the sequence 1, 3, 4, 5, 6, 8, 9, 11 using a binary search. 2

- (c) Show that $f(x) = x^2 + 2x + 1$ is $O(x^2)$. 2

End of Questions