MID-SEMESTER EXAMINATION, December-2024
Discrete Mathematics (MA 3001)

Program: MCA **Semester:1st**
Full Marks: 30 **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 negation of the following statement.   2

    "Everyone in your class is friendly."

   (b) Use the laws and check whether the following statement   2
   is a tautology or not.

    $$[\neg p \wedge (p \vee q)] \rightarrow q$$

   (c) Prove that $\sqrt{5}$ is irrational by giving a proof by   2
   contradiction.

2. (a) Use rules of inference to show that the hypotheses   2
   "Reeta works hard," *"If Reeta works hard, then she is a
   dull girl,"* and *"If Reeta is a dull girl, then she will not get
   the job"* imply the conclusion *"Reeta will not get the job."*

   (b) State the converse, contrapositive and inverse of the   2
   given conditional statement.

    "I go to the beach whenever it is sunny summer day."

   (c) Use rules of inference to show that if $\forall x \, (P(x) \rightarrow$ 2
   $(Q(x) \wedge S(x)))$ and $\forall x \, (P(x) \wedge R(x))$ are true, then
   $\forall x \, (R(x) \wedge S(x))$ is true.

3. (a) Prove the De Morgan law using set builder form.   2

    $$\overline{A \cap B} = \overline{A} \cup \overline{B}.$$

   (b) Evaluate   2

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

   (c) Let   2

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

    Find $A \vee B$.

4. (a) Determine whether the following function is a bijection   2
   from $\mathbb{R}$ to $\mathbb{R}$, if $f(x) = (x^2+1)/(x^2+2)$. Justify.

   (b) Find $f \, o \, g$ and $g \, o \, f$, where $f(x) = x^2 + 1$ and $g(x) = x + 2$ 2
   are functions from $\mathbb{R}$ to $\mathbb{R}$.

   (c) Let $f(x) = \left| \frac{x^2}{3} \right|$. Find $f(S)$, if $S = \{-1,5,7,11\}$.   2

5. (a) Use insertion sort to sort *d, f, k, m, a, b,* (as arrange in   2
   English alphabets) showing the lists obtained at each
   step.

   (b) Find the least integer n such that $f(x)$ is $O(x^n)$ for   2
   $f(x) = 3x^3 + (\log x)^4$.

   (c) Describe the time complexity of the linear search   2
   algorithm.

End of Questions