MATH M21: Discrete Mathematics

Course Objectives (COR)

- Simplify and evaluate basic logic statements including compound statements, implications, inverses, converses, and contrapositives using truth tables and the properties of logic.
- Express a logic sentence in terms of predicates, quantifiers, and logical connectives
- Apply the operations of sets and use Venn diagrams to solve applied problems; solve problems using the principle of inclusion-exclusion.
- Determine the domain and range of a discrete or non-discrete function, graph functions, identify one-to-one functions, perform the composition of functions, find and/or graph the inverse of a function, and apply the properties of functions to application problems.
- List the terms in a sequence, write a sequence in closed form, compute the sum of a finite sequence, compute the product of a finite sequence, and express sequences in terms of recursive or non-recursive forms.
- Analyze the growth of elementary functions and determine their Big-O value; analyze simple algorithms and compare two algorithms based on computational complexity.
- Use elementary number theory including the divisibility properties of numbers to determine prime numbers and composites, the greatest common divisor, and the least common multiple; perform modulo arithmetic and computer arithmetic.
- Apply algorithms to problems including searching algorithms, base conversion algorithms, and the Euclidean algorithm.
- Perform basic matrix operations including sums, products, and transpose and perform 0-1 matrix operations.
- Apply rules of inference, tests for validity, and methods of proof including direct and indirect proof forms, proof by contradiction, proof by cases, and mathematical induction and write proofs using symbolic logic and Boolean Algebra.
- Identify the base step and the recursive or inductive step in applied problems and give a recursive and a non-recursive definition for an iterative algorithm.
- Verify that a simple program segment with given initial and final assertions is correct using the rule of inference for verification of partial correctness and loop invariants.
- Solve counting problems by applying elementary counting techniques using the product and sum rules, permutations, combinations, the pigeon-hole principle, and binomial expansion.
- Solve discrete probability problems and use sets to solve problems in combinatorics and probability theory.
- Solve problems using recurrence relations and recursion to analyze algorithms and programs such as finding Fibonacci numbers, the Ackerman function and Tower of Hanoi problems.
- Solve problems using divide-and-conquer recurrence relations such as the fast multiplication algorithm and binary search.
- Describe binary relations between two sets; determine if a binary relation is reflexive, symmetric, or transitive or is an equivalence relation; combine relations using set operations and composition.
- Describe N-ary relations between N sets and apply basic database operations such as projections to N-ary relations.
- Determine if a given graph is simple or a multigraph, directed or undirected, cyclic or acyclic, and determine the connectivity of a graph.

- Represent a graph using an adjacency list and an adjacency matrix and apply graph theory to application problems such as computer networks.
- Determine if a graph has an Euler or a Hamilton path or circuit.
- Determine if a graph is a binary tree, N-ary tree, or not a tree; use the properties of trees to classify trees, identify ancestors, descendants, parents, children, and siblings; determine the level of a node, the height of a tree or subtree and apply counting theorems to the edges and vertices of a tree.
- Perform tree traversals using preorder, inorder, and postorder traversals and apply these traversals to application problems; use binary search trees or decision trees to solve problems.
- Evaluate Boolean functions and simplify expression using the properties of Boolean algebra; apply Boolean algebra to circuits and gating networks.
- Use finite-state machines to model computer operations

Course Learning Outcomes (CLO)

- Students completing this course will be able to express a logic sentence in terms of predicates, quantifiers, and logical connectives.
- Students completing this course will be able to apply the rules of inference and methods of proof including direct and indirect proof forms, proof by contradiction, and mathematical induction.
- Students completing this course will be able to use tree and graph algorithms to solve problems.
- Students completing this course will be able to evaluate Boolean functions and simplify expressions using the properties of Boolean algebra.