MATH-2010: INTRODUCTION TO DISCRETE MATHEMATICS

Cuyahoga Community College

Viewing: MATH-2010 : Introduction to Discrete Mathematics

Board of Trustees:
March 2024

Academic Term:
Fall 2024

Subject Code
MATH - Mathematics

Course Number:
2010

Title:
Introduction to Discrete Mathematics

Catalog Description:
Foundation course in discrete mathematics with applications. Topics include logic, methods of proof, mathematical induction, elementary number theory, sequences, set theory, functions, counting and probability, and graph theory.

Credit Hour(s):
4

Lecture Hour(s):
4

Requisites

Prerequisite and Corequisite
MATH-1530 College Algebra or MATH-153H College Algebra or MATH-1580 Precalculus; or qualified Math placement; or departmental approval: equivalent coursework.

Outcomes

Course Outcome(s):
Apply logical analysis to compound statements.

Objective(s):
1. Translate between English sentences and logical form.
2. Construct and interpret truth tables for compound statements involving negation, conjunction, disjunction, conditional, and biconditional connectives.
3. Apply DeMorgan's Laws to find the negations of *and* and *or* statements.
4. Define and apply tautology and contradiction.
5. Apply basic laws of equivalence to determine if statements are logically equivalent.
6. Define and apply conditional statements, negation, contrapositive, converse, inverse, biconditional statements, and necessary and sufficient conditions.
7. Define and apply arguments and argument forms.
8. Determine if an argument form is valid or invalid.
9. Recognize and apply rules of inference (e.g., modus ponens, modus tollens, generalization, specialization, conjunction, elimination, and transitivity) and fallacies (e.g., converse error and inverse error).

Course Outcome(s):
Apply logical analysis to quantified statements.

Objective(s):

1. Translate between English sentences and logical form for statements involving universal and existential quantifiers, including statements with multiple quantifiers.
2. Determine if a quantified statement involving one or two quantifiers is true or false.
3. Determine the negation of a quantified statement involving one or two quantifiers.
4. Use diagrams to determine if an argument form with quantified statements is valid or invalid.
5. Recognize and apply rules of inference and fallacies for arguments with quantified statements.

Course Outcome(s):

Apply basic methods of proof to elementary number theory.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Determine if statements involving concepts from elementary number theory are true or false.
2. Prove or disprove existential and universal statements using constructive proof of existence, the method of exhaustion, generalizing from the generic particular, and counterexample.
3. Identify logical errors in a proposed incorrect proof.
4. Prove theorems and statements using the methods of direct proof, division into cases, and proof by contradiction.

Course Outcome(s):

Apply fundamental principles of sequences and mathematical induction.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Define and apply the basic properties of sequences.
2. Compute and apply the properties of summations and products.
3. Prove conjectures by mathematical induction.
4. Define and apply recursively defined sequences.

Course Outcome(s):

Apply fundamental principles of set theory and related methods of proof.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Define and apply the basic properties of and operations on sets, including empty set, set equality, subset, proper subset, union, intersection, set difference, symmetric difference, complement, set partition, power set, and cross product.
2. Use Venn diagrams to solve problems, illustrate set identities, and apply the inclusion-exclusion principle.
3. Prove or disprove subset relations and set identities.
4. Prove a set is equal to the empty set by contradiction.

Course Outcome(s):

Apply fundamental principles of functions and related methods of proof.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Identify the domain, codomain, and range of discrete functions.
2. Define and identify functions that are one-to-one (injective), onto (surjective), and one-to-one correspondences (bijective).
3. Prove or disprove that a function is one-to-one, onto, or a one-to-one correspondence.

Course Outcome(s):

Apply fundamental principles of counting and probability.

Essential Learning Outcome Mapping:

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Define and apply the basic rules of probability.
2. Solve counting problems using the multiplication rule, permutations, distinguishable permutations, and combinations (with and without repetition).
3. Apply the addition rule and the inclusion-exclusion rule.
4. Define and apply the pigeonhole principle.

Course Outcome(s):

Apply fundamental principles of graph theory.

Essential Learning Outcome Mapping:

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Define and apply basic features and properties of graphs, including edges, vertices, the degree of a vertex, paths, circuits, bridges, subgraphs, and connected or disconnected graphs.
2. Determine if a graph has an Euler path, Euler circuit, Hamilton path, and/or Hamilton circuit, and identify them if so.
3. Define and apply basic properties of trees.

Course Outcome(s):

Apply methods and ideas learned throughout this course in different contexts.

Objective(s):

1. Investigate and solve applications related to computer science.
2. Solve other applications related to the topics learned throughout this course.

Methods of Evaluation:

1. A minimum of 3 periodic exams
2. Quizzes
3. Homework
4. In-class collaborative work
5. Computer application problems
6. Comprehensive final exam

Course Content Outline:

1. Logic
   a. Logical form
   b. Truth tables
   c. Compound statements
      i. negation
      ii. conjunction
      iii. disjunction
   d. DeMorgan's Laws
      i. negation of an *and* statement
      ii. negation of an *or* statement
   e. Tautology and contradiction
   f. Logical equivalence
   g. Conditional statements
      i. negation
      ii. contrapositive
      iii. converse
      iv. inverse
      v. biconditional statements
      vi. necessary and sufficient conditions
   h. Validity of an argument
      i. modus ponens
      ii. modus tollens
      iii. generalization
      iv. specialization
      v. conjunction
      vi. elimination
      vii. transitivity
      viii. converse error
      ix. inverse error
2. Quantified statements
   a. Logical form
   b. Universal statements
      i. truth or falsity
      ii. negation
   c. Existential statements
      i. truth or falsity
      ii. negation
   d. Statements with multiple quantifiers
      i. truth or falsity
      ii. negation
   e. Arguments with quantified statements
3. Number theory and proofs
   a. Number theory basic concepts
   b. Methods of proof
      i. constructive proof of existence
      ii. method of exhaustion
      iii. generalizing from the generic particular
      iv. counterexample
      v. direct proof
      vi. proof by division into cases
      vii. proof by contradiction
4. Sequences and proofs
   a. Properties of sequences
   b. Summations and products
   c. Proof by mathematical induction
   d. Recursively defined sequences
5. Set theory and proofs

   a. Properties of and operations on sets
      i. empty set
      ii. set equality
      iii. subset
      iv. proper subset
      v. union
      vi. intersection
      vii. set difference
      viii. symmetric difference
      ix. complement
      x. partition
      xi. power set
      xii. cross product
   b. Venn diagrams
   c. Proofs
      i. subset relations
      ii. set identities
      iii. empty set
6. Functions and proofs
   a. Discrete functions
      i. domain
      ii. codomain
      iii. range
   b. Properties of functions
      i. one-to-one (injective)
      ii. onto (surjective)
      iii. one-to-one correspondence (bijective)
   c. Proofs
      i. one-to-one
      ii. onto
      iii. one-to-one correspondence
7. Counting and probability
   a. Counting methods
      i. multiplication rule
      ii. permutation
      iii. distinguishable permutation
      iv. combination
      v. combination with repetition
   b. Addition rule
   c. Inclusion-exclusion rule
   d. Pigeonhole principle
8. Graph theory
   a. Basic features and properties of graphs
      i. edges
      ii. vertices
      iii. degree of a vertex
      iv. paths
      v. circuits
      vi. bridges
      vii. subgraphs
      viii. connected or disconnected graphs
   b. Special features of graphs
      i. Euler paths
      ii. Euler circuits
      iii. Hamilton paths
      iv. Hamilton circuits
   c. Basic properties of trees

Resources

Epp, Susanna S. *Discrete Mathematics with Applications*. 5th ed. Boston, MA: Cengage, 2020.

Rosen, Kenneth H. *Discrete Mathematics and Its Applications*. 8th ed. New York, NY: McGraw-Hill, 2019.

Lipschutz, Seymour, and Marc Lars Lipson. *Schaum's Outline of Discrete Mathematics*. 4th ed. New York, NY: McGraw-Hill, 2022.

Lipschutz, Seymour, and Marc Lars Lipson. *Schaum's 2000 Solved Problems in Discrete Mathematics*. New York, NY: McGraw-Hill, 1991.

Johnsonbaugh, Richard. *Discrete Mathematics*. 8th ed. New York, NY: Pearson, 2023.

Resources Other
Cengage WebAssign

Instructional Services

OAN Number:
Ohio Transfer 36 TMMSL

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