Southern Connecticut State University
MAT 178 Elementary Discrete Mathematics

I. Catalog Description

Catalog description: Set theory, logic, methods of proof, relations and functions, mathematical induction, recursion, graph theory, and algorithms.

II. Purpose

A. introduce the student to the abstraction process and sharpen the problem solving skills needed in mathematics and computer science courses.

B. to develop an ability and desire to continue reading, thinking about, and acting upon related issues using skills developed in the course.

C. to develop a sense of interconnectedness of ideas and knowledge.

D. to develop the ability to think critically and analytically

E. mathematics minors and computer science majors would normally take this course during their freshman year or sophomore year.

III. Credit

A. MAT 178 carries three semester-hours of university credit.

B. A student cannot get credit for both MAT 178, and MAT 250.

IV. **Prerequisites**: A student must meet both of the following prerequisites:

- MAT 139 or MAT 150
- CSC 152

V. Format

A. MAT 178 is primarily a lecture-based course.

B. A computer project which illustrates some course concepts is required.

VI. **Course Objectives**: By the end of this course, students should be able to:

A. understand the difference between valid and invalid logical arguments.

B. use sound logical arguments to prove basic claims about numbers regarding parity, divisibility, primeness.

C. use sound logical arguments to prove basic claims involving modular arithmetic and the floor and ceiling functions.

D. write proofs by induction.

E. understand the utility of mathematical definitions in the writing of mathematical proofs.

F. connect the idea of recursion with that of mathematical induction.

G. recursion relations by iteration.

H. follow an algorithm for achieving a desired result.

I. appreciate the role of definitions in the development of mathematical ideas.

J. solve real world problems in the context of graph theory.

K. solve problems completely within the abstract setting of graph theory.

VII. **Outline**

A. Speaking Mathematically: Variables, The Language of Sets, Relations and Functions

B. The Logic of Compound Statements
   1. Logical Form and Logical Equivalence
   2. Conditional Statements
   3. Valid and Invalid Arguments
   4. Digital Logic Circuits
   5. Number Systems and Circuits for Addition

C. The Logic of Quantified Statements
   1. Predicates and Quantified Statements
   2. Statements with Multiple Quantifiers

D. Methods of Proof (should use examples from Elementary Number Theory: even/odd integers, prime/composite numbers, floor/ceiling of a real number)
   1. Proving universal statements
      a. Trivial and Vacuous Proofs
      b. Direct Proofs
      c. Proofs by Contraposition
      d. Proofs by Contradiction
      e. Proofs by Cases
   2. Disproving universal statements
   3. Proving existential statements

    a. Constructive Existential Proofs
    b. Non-constructive Existential Proofs, Pigeonhole Principle
  4. Disproving existential statements

E. Sequences, Mathematical Induction, and Recursion
  1. Sequences
  2. Mathematical Induction
  3. Defining Sequences Recursively
  4. Solving Recurrence Relations by Iteration

F. Sets and Functions
  1. Basic Notations and Operations
  2. Set identities, Disproofs and Algebraic Proofs
  3. Russell's Paradox, and the Halting Problem (optional)
  4. Functions Defined on General Sets, One-to-one, Onto, and Inverse Functions

G. Graphs and Trees
  1. Graphs: Definitions and Examples
  2. Trails, Paths, and Circuits
  3. Matrix Representations of Graphs
  4. Graph Coloring and Planarity (optional)
  5. Isomorphisms of Graphs
  6. Trees: Examples and Basic Properties
  7. Rooted Trees
  8. Spanning Trees and Shortest Path Algorithms

Recommended breakdown :

- Logic (15%)
- Methods of Proof (20%)
- Mathematical Induction and Recursion (20%)
- Sets and Functions (15%)
- Graphs and Trees (20%)

Notes:

- The above schedule allows 10% for examinations and review sessions.
- While the material on graph theory appears at the end of this outline, it is critical to the Computer Science department that these topics be covered in the course. If the instructor is running short on time due to holidays, snow days, etc., then a smaller percentage of time might need to be spent on covering wide range of proof techniques.

VIII. **Proposed Text**

Susanna Epp, *Discrete Mathematics with Applications*, 4th edition, Brooks/Cole, 2011.

IX. **Waiver Policy**

This course may be waived.

X. **Prepared and Approved**

Prepared in November 2013
Approved by the Mathematics DCC on March 10, 2015
Approved by the Mathematics Department on .

XI. **Preparers**

2014: L. Brin and V. Pinciu