OFFICIAL SYLLABUS

MATH 223-Logic and Mathematical Reasoning

Adopted Spring 2019

(Committee: Drs. J. Loreaux, M.-S. Song and G. S. Staples)

Catalog Description. Concepts and techniques essential to advanced mathematics: logic, methods of proof, sets, relations, induction, functions, cardinality, combinatorics and graph theory.

Prerequisites: MATH 150 with grades of C or better.

Textbook: *Mathematical Proofs: A Transition to Advanced Mathematics, 4th edition by Gary Chartrand Albert D. Polimeni and Ping Zhang* ISBN: 978-0134746753

Course Outline:

Chapter 1 Sets
1.1 Describing a Set
1.2 Subsets
1.3 Set Operations
1.4 Indexed Collection of Sets
1.5 Partitions of Sets
1.6 Cartesian Products of Sets

Chapter 2 Logic
2.1 Statements
2.2 Negations
2.3 Disjunctions and Conjunctions
2.4 Implications
2.5 More on Implications
2.6 Biconditionals
2.7 Tautologies and Contradictions
2.8 Logical Equivalence
2.9 Some Fundamental Properties of Logical Equivalence
2.10 Quantified Statements
2.11 Characterizations

Chapter 3 Direct Proof and Proof by Contrapositive
3.1 Trivial and Vacuous Proofs
3.2 Direct Proofs
3.3 Proof by Contrapositive
3.4 Proof by Cases
3.5 Proof Evaluations

Chapter 4 More on Direct Proof and Proof by Contrapositive
4.1 Proofs Involving Divisibility of Integers
4.2 Proofs Involving Congruence of Integers

12.2 The Division Algorithm
12.3 Greatest Common Divisors
12.4 The Euclidean Algorithm
12.5 Relatively Prime Integers

Chapter 13 Proofs in Combinatorics
13.1 The Multiplication and Addition Principles
13.2 The Principle of Inclusion-Exclusion
13.3 The Pigeonhole Principle
13.4 Permutations and Combinations
13.6 The Binomial Theorem
13.7 Permutations and Combinations with Repetition

Course objectives:
At the conclusion of this course, students should be able to:
1. perform computations involving logic, sets, functions, and graphs.
2. construct proofs using the following techniques: direct, contrapositive, contradiction, induction, and combinatorial.
3. construct proofs involving basic number theory (divisibility, gcd, parity, rational numbers), sets, relations and partitions, functions (including injective and surjective properties), cardinality, and basic graph theory.
4. use counting techniques to count sets of moderate complexity.

Any instructor should cover all of the material specified, additional sections are optional