# Mathematics 3300 – Introduction to Abstract Mathematics

## ****Student Learning Outcomes****

1. ****Students will demonstrate factual knowledge of the mathematical notation and terminology used in this course****. Students will demonstrate the ability to read, interpret, and use the vocabulary and symbolism of propositional calculus, proof methods, set theory, functions, cardinality, and discrete structures.

1. **Students will demonstrate knowledge of fundamental methods of proof and problem solving.** Students will demonstrate the ability to read and comprehend mathematical arguments utilizing direct and indirect proof, case analysis, and mathematical induction.

1. **Students will apply course material along with techniques and procedures covered in this course to prove theorems and solve problems.**  Students will use the knowledge gained in this course to determine appropriate methods of proof for specific problems and to develop and write formal mathematical arguments.
2. **Students will develop specific skills, competencies, and thought processes sufficient to support further study or work in this field or related fields.**

Students will acquire proficiency in the fundamental concepts of set theory, logic, functions, properties of the real number system, and methods of proof, at a level necessary for more advanced mathematics courses such as linear and abstract algebra, real and complex analysis, and topology.

## Course Content

**Textbook:** [http://people.uleth.ca/~dave.morris/books/proofs+concepts.pdf](http://people.uleth.ca/~dave.morris/books/proofs%2Bconcepts.pdf)

**Ch. 1, Propositional Logic:** Assertions, deductions, and validity, Logic puzzles, Using letters to symbolize assertions, Connectives, Determining whether an assertion is true, Tautologies and contradictions, Logical equivalence, Converse and contrapositive, Some valid deductions.

**Ch. 2, Two-Column Proofs:** First example of a two-column proof, Hypotheses and theorems in two-column proofs. Subproofs for implication-introduction, Proof by contradiction, Proof strategies, Counterexamples.

Ch. 3, Sets: Propositional Logic is not enough, Sets, subsets, and predicates, Operations on Sets.

Ch. 4, First-Order Logic: Quantifiers, Translating to First-Order Logic, Negations, The introduction and elimination rules for quantifiers, Some proofs about sets, Counterexamples (reprise).

Ch. 6, Functions: Cartesian product, Informal introduction to funcitons, Official definition, One-to-one functions, Onto functions, Bijections, Inverse functions, Composition of functions, Image and pre-image.

Ch. 8, Proof by Induction: The Principle of Mathematical induction, Other proofs by induction, Other versions of induction, The natural numbers are well-ordered.

Ch. 9, Cardinality: Definition and basic properties, The Pigeonhole Principle, Cardinality of a union, Hotel Infinity and the cardinality of infinite sets, Countable sets, Uncountable sets.

Optional: Portions of Ch. 5 (number theory, commutative groups, convergent sequences), portions of Ch. 8 (equivalence relations).