

MATH 301 Advanced Topics in Elementary Mathematics

Course objectives:

1. Explore a variety of advanced mathematical topics from a non-technical perspective.
2. Develop students' ability to represent, analyze and solve mathematical problems.
3. Develop students' ability to use appropriate technology, such as graphing calculators, spreadsheets and dynamic geometry software, to model, explore and solve mathematical problems.
4. Develop students' ability to construct and communicate correct, clear and convincing mathematical arguments (e.g. proofs).
5. Develop students' understanding of the history of mathematical ideas and their development in Western and non-Western cultures.

Usual course content:

Unit 1: Problems: Representing, Solving and Communicating

A variety of rich problems from different areas are used to develop students' ability to do the mathematical processes of representing, problem solving and communicating. In addition, problems are used to briefly introduce students to new mathematical areas such as fractals, modular arithmetic and infinity.

Unit 2: Topics from Number Theory

Students explore a variety of topics, such as Fibonacci numbers, prime number conjectures, modular arithmetic, codes and check-digit algorithms. As they explore the mathematical content, students also use appropriate technology (such as spreadsheets to explore number sequences).

Unit 3: Infinity

Students explore basic set theory and infinite sets. The idea of the cardinality of sets is developed and explored. Students are generally introduced to diagonal arguments and geometric projections.

Unit 4: Multi-cultural Mathematics and the History of Mathematical Ideas

Students will research the rich history of mathematical ideas from a variety of topics, such as number, geometry, algebra, measurement, statistics and calculus. The historical contributions of Western and non-Western cultures will be discussed, culminating in a "timeline" of mathematical ideas constructed by the class. Students will also write individual reports communicating their understanding.

Unit 5: Geometry/Topology

Students explore topics such as proofs of the Pythagorean Theorem, Golden Rectangles, non-periodic tessellations, the fourth dimension, spherical geometry, taxicab geometry and two-dimensional manifolds. Throughout the unit students become familiar with appropriate models and technological tools.

Unit 6: Fractals

Students explore the idea of similar and self-similar objects. They construct and analyze a variety of fractals, such as the Koch Snowflake and Sierpinski triangle. They will explore other fractal objects such as Julia sets and the Mandelbrot set. Throughout the unit students will explore and deepen their understanding of the concept of dimension.

Unit 7: Probability and Statistics

Students will explore a variety of topics involving data, such as the Law of Large Numbers, conditional probability, distributions, survey design, risk analysis and voting theory.

Technology:

Students will use appropriate technology throughout the course, such as graphing calculators, spreadsheet software, dynamic geometry software and the Internet.

Students who may benefit:

This course is specifically designed for prospective elementary and middle school teachers who are mathematics majors or minors.

Follow up courses:

MATH 381 The Teaching of Mathematics K-6