MATH 0018 - THE NATURE OF MATHEMATICS

Catalog Description

Prerequisite: Completion of Intermediate Algebra or appropriate placement
Hours: 54 lecture
Description: Introduces students to the art and application of mathematics in the world around them. Topics include mathematical modeling, voting and apportionment, and mathematical reasoning with applications chosen from a variety of disciplines. Not recommended for students entering elementary school teaching or business. (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Solve college level math problems from a variety of different areas.
- CSLO #2: Utilize linear, quadratic, exponential, and logarithmic equations, systems of equations, and their graphs to analyze mathematical applications from various disciplines.
- CSLO #3: Analyze given information and implement strategies for solving problems involving mathematical and logical reasoning.
- CSLO #4: Use mathematical modeling as a problem solving tool in other disciplines and contexts.
- CSLO #5: Logically present clear, complete, accurate, and sufficiently detailed solutions to communicate reasoning and demonstrate the method of solving problems.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

54

Outside of Class Hours

108

Total Student Learning Hours

162

Course Objectives

1. Solve college level math problems from a variety of different mathematical subject areas, especially topics not usually covered in a traditional mathematics course.
2. Analyze given information and develop strategies for solving problems involving mathematical and logical reasoning.
3. Recognize and apply the concepts of mathematics as a problem-solving tool in other disciplines and contexts.
4. Utilize linear, quadratic, exponential, and logarithmic equations, systems of equations, and their graphs to analyze mathematical applications from various disciplines.
5. Compare and contrast apportionment methods and voting systems, using an appropriate level of mathematics to support any conclusions.

General Education Information

- Approved College Associate Degree GE Applicability
  - AA/AS - Comm & Analyt Thinking
  - AA/AS - Mathematical Skills
- CSU GE Applicability (Recommended-requires CSU approval)
  - CSUGE - B4 Math/Quantitative Reasoning
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)
  - IGETC - 2A Math/Quan Reasoning

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Objective Examinations
  - Example: A five-member committee has the following voting system. The chairperson can pass or block any motion that she supports or opposes, provided that at least one other member is on her side. Show that this voting system is equivalent to the weighted voting system [4:3, 1, 1, 1, 1]. Student performance is graded based on correctness and completeness of solution.
- Problem Solving Examinations
  - Example: In class, we saw that a regular pentagon cannot tile the plane. Suppose you cut the pentagon in half. Can this new shape tile the plane? Explain your answer. Student performance will be measured on correctness of solution, as well as clarity of written explanation.
- Projects
  - Example: Fibonacci/Golden Ratio project (Create something that utilizes Fibonacci numbers and/or the Golden Ratio in multiple ways. Write an explanation showing how these numbers were incorporated and demonstrate understanding of the concepts.) will be graded on the following criteria: The Fibonacci project should: a. Show an outstanding relationship to Fibonacci numbers/the Golden Ratio on multiple levels b. Be unique and show a good effort. c. Be well-presented d. Be turned in on time and be complete. Classroom students will turn in a physical project, online students may create a digital project, or submit photos or a video presenting their project for the instructor and other students in the class to see.

Repeatable

No

Methods of Instruction

- Lecture/Discussion
- Distance Learning

Lecture:

1. While constructing a Koch Snowflake, students will determine the perimeter of the fractal after each recursive step. This will lead to developing a rule for the ratio of increase in perimeter at each step, and a conclusion that the perimeter of the fractal is infinite. Students

will compare and contrast geometric and natural fractals, and come to understand the Coastline Paradox. Instructor will lead the students through the exploration, providing guidance as needed. (Objective 1)
2. Students will act out the roles of family members inheriting an estate and use the Method of Sealed Bids to divide the estate fairly. Instructor will set up the situation and each group of students will play a character. (Objective 2)

Distance Learning

1. Students will vote in an election using preference ballots. These would be on paper in a classroom or survey style in an online class. They will then build a preference schedule and determine the winning candidate using four different voting methods. Students will also determine if there is a Majority Candidate and/or a Condorcet Candidate. Instructor will facilitate the activity, providing ballots and guidance as needed. (Objective 5)
2. After presentation of the "Seven Bridges of Konigsberg" problem (in person or on a video for online students), students will create a graph of the situation and use Euler's Circuit Theorem to determine if there is a solution. After Eulerizing the graph, students will apply Fleury's Algorithm to find a circuit. Instructor will demonstrate the algorithm through an online video or in the classroom environment before students break into group and apply it. (Objective 4)
3. Students working in pairs in a classroom environment will run an experiment based on the Monty Hall Problem. Online students will run an interactive Monty Hall simulator. Class will collect data and determine the experimental and theoretical probability of winning the game. Instructor will provide rules, facilitate the experiment, and clarify the results. (Objective 2)

Typical Out of Class Assignments Reading Assignments

1. Read selections in the textbook or online concerning the Fibonacci sequence. One example is at http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Fibonacci/fibnat.html Be prepared to discuss in class where we find Fibonacci numbers and why they occur in nature so frequently. 2. Read an article about how the Best Picture Oscar winner is chosen, and compare and contrast this method to one of the voting methods studied in class. How does this method hold up the Arrow's Fairness Criteria? Be prepared to discuss in class. 3. Research examples of how the Golden Ratio has been used by humans to creatively (for example in art or architecture). Show understanding of where and how exactly this mathematical ratio is incorporated into the chosen examples and be prepared to discuss in class.

Writing, Problem Solving or Performance

1. Create a weighted voting system with 4 members in which 1 person has veto power. Calculate the Banzhaf Power Index for the system. Compare this system to a voting system with 5 members in which one person equals one vote. Calculate the Banzhaf Power Index for this system and use it in your discussion. 2. Use the Division Algorithm to show that the remainder when a number n is divided by m is equal to the position n would be on a mod m clock. 3. Public Key Encryption: Using the 2 public numbers 7 and 143, encode the following string of numbers: "2 83 3 61 38". 4. Write about the relationships between the Fibonacci sequence and the Golden ratio. How are a Fibonacci spiral and a Golden spiral different? 5. Create a population sequence model for a given species. Write the model in infinite list notation, using a recursive formula, and using an explicit formula.

Other (Term projects, research papers, portfolios, etc.)

1. Create a graph model of a residential neighborhood from Google Maps for a mail carrier route. After determining the degree of each vertex, Eulerize the graph and find a route for the mail carrier to deliver the mail to all the residents. 2. Create something that utilizes Fibonacci numbers and/or the Golden Ratio in multiple ways. Write an explanation showing how these numbers were incorporated and demonstrate understanding of the concepts.

Required Materials

- Excursions in Modern Mathematics
  - Author: Peter Tannenbaum
  - Publisher: Prentice Hall
  - Publication Date: 2018
  - Text Edition: 9th
  - Classic Textbook?: No
  - OER Link:
  - OER:
- Mathematics for the Liberal Arts
  - Author: David Lippman
  - Publisher: Lumen Learning
  - Publication Date: Current (OER)
  - Text Edition:
  - Classic Textbook?: No
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.