

**Course: Discrete Mathematics**  
**Year: 2009 - 2010**  
**Instructor: Mrs. Gillingham**

**Course philosophy:** Welcome to discrete math! This course is extremely interesting and fun. We study many math topics that you probably have not seen in the past. Mathematics helps to strengthen our knowledge of the world that we inhabit. Through these endeavors, we learn to understand and appreciate the beauty of our surroundings even more. Throughout the course, emphasis is placed on the processes used to determine solutions to the problems, not on the solutions themselves. We learn different problem-solving strategies to find solutions and we learn how to explain our methods in both oral and written form. This course is an exciting adventure. Enjoy the journey!

**Materials required:** Text  
Graphing calculator (TI-84 Plus)  
Notebook for homework

**Classroom expectations:**

1. Come to class on time.
2. Come to class prepared. Bring all the required materials and completed homework to class each day.
3. When you arrive in class, immediately get out your homework and begin work on the indicated warm-up exercise. Do not wait for me to start class.
4. You are responsible for any material covered or announcements made during your absence.
5. Respect yourself and others. Dishonest and inappropriate behaviors are not acceptable.
6. Finally, give each task your best effort and remain positive. You may find some of the concepts and problems quite challenging, but do not give up. There is great satisfaction found in persevering until a concept is mastered! Mathematics is an extremely interesting and exciting subject to explore!

**Homework policies:**

Mathematics is a skill, and, like all skills, it must be practiced. Homework is an important part of the learning process and is assigned almost every night. All homework should be done in pencil and kept in a notebook. It must be labeled with the page number and problem numbers. You must include the work for each problem, not just the answer. Most assignments are due at the beginning of the next class period. The maximum amount of focused, uninterrupted time spent on math homework should be 30 minutes/night for a regular course and 40 minutes/night for an honors course.

**Grading procedure:**

Grades are determined by points earned out of points possible. Major tests are cumulative and are always announced; quizzes may or may not be announced. Weighting factors are as follows:

tests and quizzes	90%
homework	10%

All grading procedures follow the policies written in the Student Handbook. To emphasize the importance of growth throughout the school year, the first trimester will count as 15% of your final grade, the second trimester as 25%, the third trimester as 35%, the mid-year exam as 10%, and the final exam as 15%.

**Tentative Discrete Math Schedule****Text: Mathematical Excursions  
(Aufmann, Lockwood, Nation & Clegg, 2007)**

<u>Week</u>	<u>Chapters</u>	<u>Sections</u>	<u>Topics</u>
1	1	All	Problem solving
2	1	All	Problem solving
3	1	All	Problem solving
4	2	All	Sets
5	2	All	Sets
6	2	All	Sets
7	3	All	Logic
8	3	All	Logic
9	3	All	Logic
10	3	All	Logic
11	4	All	Numeration systems and number theory
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12	4	All	Numeration systems and number theory
13	4	All	Numeration systems and number theory
14	4	All	Numeration systems and number theory
15	4	All	Numeration systems and number theory
16	7	All	Mathematical systems
17	7	All	Mathematical systems
18	7	All	Mathematical systems
19	9	All	Mathematics of graphs
20			Review and mid-year exam
21	9	All	Mathematics of graphs
22	9	All	Mathematics of graphs
23	11	All	Combinatorics and probability
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24	11	All	Combinatorics and probability
25	11	All	Combinatorics and probability
26	11	All	Combinatorics and probability
27	11	All	Combinatorics and probability
28	12	All	Statistics
29	12	All	Statistics
30	12	All	Statistics
31	12	All	Statistics
32	8	8.6 & 8.7	Non-Euclidean geometry; fractals
33	8	8.6 & 8.7	Non-Euclidean geometry; fractals
34			Review
35			Final exam

# Discrete Mathematics Outline

## **I. Problem solving**

- A. Inductive vs. deductive reasoning
  - 1. Conjecture
  - 2. Counterexamples
- B. Problem solving with patterns
  - 1. Terms of a sequence
    - a. First, second, and third differences
    - b.  $n$ th term formula
  - 2. Fibonacci sequence
- C. Problem solving strategies
  - 1. Polya's four-step problem-solving strategy
  - 2. Reading and interpreting graphs

## **II. Sets**

- A. Basic properties of sets
  - 1. Representations
    - a. Roster method
    - b. Word description
  - 2. Definitions
    - a. Equal sets
    - b. Equivalent sets
    - c. Fuzzy sets
- B. Complements, subsets, and Venn diagrams
  - 1. Universal set
  - 2. Proper subsets
  - 3. Number of subsets of a set
- C. Set operations
  - 1. Intersection
  - 2. Union
  - 3. De Morgan's Laws
  - 4. Properties of sets
    - a. Commutative
    - b. Associative
    - c. Distributive
- D. Applications of sets
  - 1. Surveys
  - 2. Inclusion-Exclusion Principle
  - 3. Percent Inclusion-Exclusion Formula
- E. Infinite sets
  - 1. One-to-one correspondence
  - 2. Cardinality of infinite sets

## **III. Logic**

- A. Logic statements and quantifiers
  - 1. Compound statements
    - a. Conjunctions
    - b. Disjunctions
  - 2. Truth value and truth tables
  - 3. Negation
- B. Truth tables, equivalent statements, and tautologies
- C. Conditional and biconditional
- D. Conditional and related statements
  - 1. Equivalent forms of the conditional
  - 2. Converse, inverse, and contrapositive
- E. Arguments
  - 1. Validity and truth tables
  - 2. Standard forms of four valid arguments
    - a. Modus ponens
    - b. Modus tollens
    - c. Law of syllogism
    - d. Disjunctive syllogism
  - 3. Fallacies
    - a. Fallacy of the converse
    - b. Fallacy of the inverse
- F. Euler diagrams

#### **IV. Numeration systems and number theory**

- A. Early numeration systems
  - 1. Egyptian hieroglyphics
  - 2. Roman numeration system
- B. Place-value systems
  - 1. Expanded form
  - 2. Babylonian numeration system
  - 3. Mayan numeration system
  - 4. Nines complement and end-around carry
- C. Different base systems
  - 1. Converting non-base-ten numerals to base ten
  - 2. Converting from base ten to another base
  - 3. Converting directly between computer bases
  - 4. Double-dabble method
- D. Arithmetic in different bases
  - 1. Addition
  - 2. Subtraction
  - 3. Multiplication
  - 4. Division
- E. Prime numbers
  - 1. Divisibility tests
  - 2. Prime factorization
  - 3. Prime deserts
- F. Topics from number theory
  - 1. Perfect, deficient, and abundant numbers

2. Mersenne numbers and perfect numbers
3. Fermat's Last Theorem

## V. Mathematical systems

- A. Modular arithmetic
  1. Arithmetic operations modulo  $n$
  2. Solving congruence equations
  3. Additive and multiplicative inverses in modular arithmetic
- B. Applications of modular arithmetic
  1. ISBN, UPC, and credit card numbers
  2. Cryptology
- C. Introduction to group theory
  1. Definition of a group
  2. Symmetry groups
  3. Permutation groups
  4. Wallpaper groups

## VI. Mathematics of graphs

- A. Traveling roads and visiting cities
  1. Definitions
  2. Euler circuits
  3. Euler walks
  4. Hamiltonian circuits
- B. Efficient routes
  1. Weighted graphs
  2. Algorithms in complete graphs
    - a. The Greedy Algorithm
    - b. The Edge-Picking Algorithm
  3. Applications of weighted graphs
- C. Planarity and Euler's Formula
- D. Map coloring and graphs
  1. Maps become graphs
  2. Chromatic number of a graph
  3. Applications of graph coloring

## VII. Combinatorics and probability

- A. The Counting Principle
  1. Methods of counting
    - a. By forming a list
    - b. By making a table
    - c. By using a tree diagram
    - d. By using the Counting Principle
  2. Counting with and without replacement
- B. Permutations and combinations
  1. Factorial

2. Definitions
3. Permutation formula for distinct objects
4. Permutations of indistinguishable objects
5. Combination formula
6. Applying several counting techniques
- C. Probability and odds
  1. Theoretical probability
  2. Empirical probability
  3. Relationship between odds and probability
- D. Addition and Complement Rules
  1. Mutually exclusive events
  2. Complement of an event
- E. Conditional probability
  1. Product Rule
  2. Independent events
  3. Applications
- F. Expectation

## VIII. Statistics

- A. Measures of central tendency
  1. Mean, median, and mode
  2. Comparative properties of mean, median, and mode
  3. Weighted mean
- B. Measures of dispersion
  1. Range
  2. Standard deviation
  3. Variance
- C. Measures of relative position
  1. z-scores
  2. Percentiles
  3. Quartiles
  4. Box-and-whisker plots
  5. Stem-and-leaf plots
- D. Normal distributions
  1. Frequency distributions and histograms
  2. Types of distributions
    - a. Uniform
    - b. Bimodal
    - c. Symmetrical
    - d. Skewed
  3. The Empirical Rule
  4. Standard normal distribution
  5. Applications
- E. Linear regression and correlation

## IX. Geometry

- A. Non-Euclidean geometry
  - 1. Euclidean geometry vs. non-Euclidean geometry
  - 2. Gauss's alternative to the Parallel Postulate
  - 3. Riemann's alternative to the Parallel Postulate
  - 4. Lobachevskian or hyperbolic geometry
  - 5. Riemannian or spherical geometry
  - 6. City geometry: a contemporary non-Euclidean geometry
- B. Fractals
  - 1. Strictly self-similar fractals
  - 2. Replacement ratio and scaling ratio
  - 3. Similarity dimension
  - 4. Koch snowflake
  - 5. Highway dragon fractal