



West Windsor-Plainsboro Regional School District
Introduction to Discrete Mathematics
April 2022

Unit 1: Graph Theory	
Content Area: Mathematics	
Course & Grade Level: Discrete Math, grades 9-12	
Summary and Rationale	
Elaborate communication networks span the country and most of the Earth. The ability to transmit information quickly and easily through these networks affects many areas of our lives. The mathematics of graph theory plays an important role in designing and updating different networks. Another place we find the use of graph theory is in the work of cartographers. When boundaries change, cartographers have to provide the public with new maps. For years cartographers and mathematicians have studied the best way to color these maps. Whether you are a cartographer, a business person who must make a schedule with competing constraints or a city planner deciding which roads are the most efficient, you will find the answer using graph theory.	
Recommended Pacing	
4 days (12 hours)	
New Jersey Student Learning Standards for	
Standard: Standards for Mathematical Practice	
CPI #	Cumulative Progress Indicator (CPI)
MP1	Make sense of problems and persevere in solving them.
MP2	Reason abstractly and quantitatively.
MP3	Construct viable arguments and critique the reasoning of others.
MP4	Models with mathematics.
MP5	Use appropriate tools strategically.
MP6	Attend to precision.
MP7	Look for and make use of structure.
MP8	Look for and express regularity in repeated reasoning.
New Jersey Student Learning Standards for English Language Arts Companion Standards	
Standard: Science Key Ideas and Details	
CPI #	Cumulative Progress Indicator (CPI)
RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills	
CPI #	Cumulative Progress Indicator (CPI)
9.4.5.CI.3	Participate in a brainstorming session with individuals with diverse perspectives to expand one's thinking about a topic of curiosity (e.g., 8.2.5.ED.2, 1.5.5.CR1a).
9.4.5.CT.3	Describe how digital tools and technology may be used to solve problems.
9.4.5.CT.4	Apply critical thinking and problem-solving strategies to different types of problems such as personal, academic, community and global (e.g., 6.1.5.CivicsCM.3).
New Jersey Student Learning Standards for Technology	
CPI #	Cumulative Progress Indicator (CPI)
8.1	All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

8.2	All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
Interdisciplinary Standards Design Thinking	
8.2.12.NT.1	Explain how different groups can contribute to the overall design of a product.
Core Idea	
Engineers use science, mathematics, and other disciplines to improve technology. Increased collaboration among engineers, scientists, and mathematicians can improve their work and designs.	
Instructional Focus	
Unit Enduring Understandings	
<ul style="list-style-type: none"> Graph theory helps us model the connections in the world 	
Unit Essential Questions	
<ul style="list-style-type: none"> How do mathematicians gain efficiency on models by applying graph theory? 	
Objectives	
<p>Students will know: Vocabulary: critical path, adjacent, complete graph, valence, degree of a vertex, edge, loop, multigraph</p> <p>Students will be able to:</p> <ul style="list-style-type: none"> Model a problem by making a graph Determine a critical path and shortest route in a network or graph Describe and utilize Euler circuits and paths Describe and utilize Hamiltonian circuits and paths Color a map with the least amount of colors 	
Evidence of Learning	
Assessment	
Teacher formative assessment is embedded in the course. Each unit has an associated project.	
Resources	
Teacher made resources	

Unit 2: Fractals

Content Area: Mathematics

Course & Grade Level: Discrete Math, grades 9-12

Summary and Rationale

A fractal is defined as a jagged or fragmented geometric shape which can be split into parts that are considered a reduced copy of the whole. Although the study of fractals has existed as early as the 17th century, the term fractal was only coined in 1975 by Benoit Mandelbrot, fractals are the backbone behind scientific concepts. They help give us a better idea of how bacteria grows, insight into how water freezes (snowflakes!), and even better comprehension of brain waves. The formulas are so intricate that studying them has led to numerous scientific breakthroughs.

Recommended Pacing

4 days (12 hours)

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New Jersey Student Learning Standards for English Language Arts Companion Standards

Standard: Science Key Ideas and Details

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New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills

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Instructional Focus
Unit Enduring Understandings
<ul style="list-style-type: none"> ● Fractals are visual models for geometric growth
Unit Essential Questions
<ul style="list-style-type: none"> ● How do fractals help us model growth that cannot be modeled algebraically? ● How does a small change in an iterative process change the outcome?
Objectives
<p>Students will know: Vocabulary: iteration, recursion, self-similarity</p> <p>Students will be able to:</p> <ul style="list-style-type: none"> ● Create a complex pattern by repeating a simple process ● Generate and analyze fractal patterns ● Find an algebraic model for a fractal ● Use mathematics to describe changes in area and perimeter
Evidence of Learning
Assessment
Teacher formative assessment is embedded in the course. Each unit has an associated project.
Resources
Teacher made resources

Unit 3: Combinatorics	
Content Area: Mathematics	
Course & Grade Level: Discrete Math, grades 9-12	
Summary and Rationale	
Chance and risk play a role in everyone’s life. No doubt, you have heard the question, “What are the chances?” Often questions of probability are associated with questions of counting. In order to determine the probability of winning the lottery, a mathematician must calculate the number of different ways you can select your numbers from those available. In this unit, you will examine a variety of questions about counting and probability that are fundamental to modeling random events.	
Recommended Pacing	
4 days (12 hours)	
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Instructional Focus	

Unit Enduring Understandings

- When a set has a large number of members, it is inefficient to list them all in order to count them.

Unit Essential Questions

- How do mathematicians count the members of a discrete set?
- Does order matter?
- How does probability help predict the future?

Objectives**Students will know:**

Vocabulary: Odds, probability, compound events, independent events, dependent events, permutation and combination, factorial

Students will be able to:

- Apply the counting principle
- Use permutations and combinations to count the members of finite sets
- Find the probability of independent, dependent and compound events
- Discuss the odds and probabilities of certain events

Evidence of Learning**Assessment**

Teacher formative assessment is embedded in the course. Each unit has an associated project.

Resources

Teacher made resources

Unit 4: Cryptology

Content Area: Mathematics

Course & Grade Level: Discrete Math, grades 9-12

Summary and Rationale

Codes seem to be everywhere. There are Universal Product Codes (UPC) on everything you buy. There are ZIP codes and codes for access to your bank account. Two-factor authentication is also a type of code. A code is nothing more than a symbolic way to represent information. Its purpose might be to improve the flow of information as is the case with UPC and ZIP codes. But a code's purpose could be to protect sensitive information like your bank or social media account information. The science of coding is a type of mathematical modeling that has provided answers to important questions that have arisen during the Information Age. You will see how some of these codes were developed during this unit.

Recommended Pacing

4 days (12 hours)

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Instructional Focus	
Unit Enduring Understandings	
<ul style="list-style-type: none"> ● Codes help protect sensitive information and improve the flow of information 	
Unit Essential Questions	
<ul style="list-style-type: none"> ● What makes a good code? 	
Objectives	
<p>Students will know: Vocabulary: code, cipher, key</p> <p>Students will be able to:</p> <ul style="list-style-type: none"> ● Explain codes used in everyday life e.g.: UPC, ZIP, ISBN ● Generate codes using a viable, replicable, mathematical process ● Discuss different types of keys and ciphers for codes 	
Evidence of Learning	
Assessment	
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Teacher made resources	