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## Discrete Mathematics

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<th>Time Frame</th>
<th>Standard- 20 days</th>
<th>Block- 10 days</th>
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### Topic
- Election Theory

### Essential Questions
- How are the wishes of many individuals combined to yield a single result?
- Do the methods for doing so always treat each choice fairly?
- If not, is it possible to improve on these methods?

### Enduring Understandings
- Election Activity
- Group-Ranking Methods and Algorithms
- More Group-Ranking Methods and Paradoxes
- Arrow’s Conditions and Approval Voting
- Weighted Voting and Voting Power
- Proportional Representation

### Alignment to New Jersey Student Learning Standards
- N-RN.3.
- N-Q.1.
- N-Q.2.
- S-IC.3.

### Key Concepts and Skills
- Rank items, collect votes, and combine rankings
- Explore plurality and majority winners
- Describe runoff methods
- Examine data for a Condorcet winner and paradox
- Determine arrow’s conditions
- Explore approval voting
- Determine weighted voting & voting power
- Investigate proportional voting

### Learning Activities
- Soft Drink Voting Activity
- Run Off Elections Exploration
- Google Page Discussion

### Assessments
- Voting activities
- Completing exercise questions
- Quiz on Group-Ranking Method
- Election Theory Test

### 21st Century Skills

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<thead>
<tr>
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<td>Media Literacy</td>
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</tbody>
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### Interdisciplinary Connections
- Social Studies and History of Elections

### Technology Integration
- 8.1 Educational Technology- All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.
- LCD Projector
- Document Camera
- Laptop Computer
- Internet Websites Such as Google
### Discrete Mathematics

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#### Essential Questions

How can a portion of food be divided fairly among two or more children?  
Is the meaning of fairness when food is divided among children differently from the meaning of fairness when an estate is divided among heirs or when seats in Congress are divided among states? Are the methods that are commonly used to divide food, estates, and legislatures necessarily the fairest methods?

#### Enduring Understandings

- A Fair Division Activity  
- Estate Division  
- Apportionment Algorithms  
- More Apportionment Algorithms and Paradoxes  
- Fair Division Algorithms: The Continuous Case  
- Mathematical Induction  
- Envy-Free Division

### Alignment to New Jersey Student Learning Standards

- N-RN.3, N-Q.2, S-IC.1.

#### Key Concepts and Skills

- Explore divisions of food and property  
- Apply knowledge of weighting to determine fairness of situations  
- Determine averages  
- Understand and utilize properties of algorithms

#### Learning Activities

- Estate division project  
- Evaluation of Census

#### Assessments

- Completing exercise questions  
- Estate division project  
- Quiz on algorithms  
- Census activity  
- Fair Division Test

#### 21st Century Skills

<table>
<thead>
<tr>
<th>Creativity</th>
<th>x</th>
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#### Life & Career Skills

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### Interdisciplinary Connections

### Technology Integration

8.1 Educational Technology- All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

- LCD Projector  
- Document Camera  
- Laptop Computer  
- Internet Websites
# Discrete Mathematics

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Standard- 25 days</th>
<th>Block- 12 days</th>
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</thead>
</table>

## Topic
Matrix Operations and Applications

## Essential Questions
- How can large collections of data be organized and managed in an efficient way?
- What calculations provide meaningful information to people who use the data?
- How can computers and calculators assist them?

## Enduring Understandings
- Addition and Subtraction of Matrices
- Multiplication of Matrices
- Population Growth: Leslie Model
- Keyword Matrices

## Alignment to New Jersey Student Learning Standards
- N-VM.5.
- N-VM.6.
- N-VM.7.
- N-VM.8.
- N-VM.9.

## Key Concepts and Skills
- Utilize properties of matrices - addition, subtraction & multiplication
- Understand Population Growth
- Utilize the Leslie Model

## Learning Activities
- Patterns for Profit Project
- Population Growth Project
- Coding & Decoding messages

## Assessments
- Completing exercise questions
- Quiz on basic operations with Matrices
- Projects – Population Growth & Patterns for Profit
- Matrices Operations & Application test

## 21st Century Skills

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<tr>
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</table>

## Interdisciplinary Connections
- Social Population Growth

## Technology Integration
- 8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.
- LCD Projector
- Document Camera
- Laptop Computer
- Graphing Calculators
- Internet Websites
## Discrete Mathematics

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Standard- 25 days</th>
<th>Block- 14 days</th>
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<tbody>
<tr>
<td><strong>Topic</strong></td>
<td>Graphs and Their Applications</td>
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</tr>
<tr>
<td><strong>Essential Questions</strong></td>
<td>What is the minimum number of colors needed to color any map? Optimally, how do you color a map? What do coloring maps and scheduling meetings times for your school organizations have in common?</td>
<td></td>
</tr>
<tr>
<td><strong>Enduring Understandings</strong></td>
<td>Modeling Projects Critical Paths The Vocabulary and Representations of Graphs Euler Circuits and Paths Hamiltonian Circuits and Paths Graph Coloring Eulerizing Graphs</td>
<td></td>
</tr>
<tr>
<td><strong>Alignment to New Jersey Student Learning Standards</strong></td>
<td>N-Q.1., N-Q.2., N-Q.3.</td>
<td></td>
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<tr>
<td><strong>Key Concepts and Skills</strong></td>
<td>Explore modeling projects with graphical representation Evaluate the most efficient critical path Understand vocabulary &amp; representation of graphs Explore Matrix representation of graphs Investigate the Euler &amp; Hamiltonian circuits &amp; paths</td>
<td></td>
</tr>
<tr>
<td><strong>Learning Activities</strong></td>
<td>Map design project Mail carrier packet Eulerizing Graph Exploration</td>
<td></td>
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<tr>
<td><strong>Assessments</strong></td>
<td>Completing exercise questions Quiz on vocabulary of graphs Euler &amp; Hamiltonian circuits Circuits Quiz Graphs and Their Applications Test</td>
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<td><strong>21st Century Skills</strong></td>
<td>x Creativity x Critical Thinking Communication x Collaboration x Life &amp; Career Skills Information Literacy Media Literacy</td>
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<tr>
<td><strong>Interdisciplinary Connections</strong></td>
<td>History of the Rival Between Hamilton and Jefferson</td>
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<tr>
<td><strong>Technology Integration</strong></td>
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</tbody>
</table>
Discrete Mathematics

| Time Frame | Standard- 22 days | Block- 11 days |

**Topic**
More Graphs, Subgraphs and Trees

**Essential Questions**
How communication networks that link several locations together are constructed at the least possible cost?
How is the most efficient route between two locations in a network found?
Can the methods used to find the best route between points in a communication network also be used to plan the best route for an automobile or plane trip?

**Enduring Understandings**
Planarity and Coloring
The Traveling Salesperson Problem
Finding the Shortest Route
Trees and Their Properties
Minimum Spanning Trees
Binary Trees, Expression Trees and Traversals Steiner Trees

**Alignment to New Jersey Student Learning Standards**

**Key Concepts and Skills**
- Explore Planarity and Coloring
- Describe Bipartite graphs
- Understand Algorithms
- Determine the shortest route
- Exploration of Tree & Properties

**Learning Activities**
- Planarity & Coloring
- Finding the shortest route
- Finding spanning trees

**Assessments**
Completing exercise questions
Quiz on algorithms
Quiz on shortest route
Project on Trees
Graphs, Subgraphs and Trees Test

**21st Century Skills**

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<th>Communication</th>
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<td>Media Literacy</td>
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**Interdisciplinary Connections**
Social Studies & History

**Technology Integration**
8.1 Educational Technology- All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

- LCD Projector
- Laptop Computer
- Document Camera
- Internet Websites
- Graphing Calculators
# Discrete Mathematics

**Time Frame**
- Standard: 20 days
- Block: 12 days

**Topic**
Counting and Probability

**Essential Questions**
- In how many ways can a lottery participant choose several numbers from those on a lottery ticket?
- What is the probability of winning a lottery jackpot?
- What is the probability that a medial test’s results are correct?
- How has an understanding of probability helped improve reliability of U.S. space shuttle launches?

**Enduring Understandings**
- A Counting Activity
- Counting Techniques
- Probability
- Monte Carlo Methods

**Alignment to New Jersey Student Learning Standards**

**Key Concepts and Skills**
- Define & Explore Counting Techniques (mutually exclusive & disjoint)
- Understand Probability, Permutation & Factorials
- Work with combinations of Probability, Permutation & Factorials
- Understand Binomial Probability Distribution

**Learning Activities**
- Lottery Activity
- Probability Activity (Die, cards, & Chips)
- Combining probability with permutation & probability with combinations

**Assessments**
- Completing exercise questions
- Quiz on Multiplication & Addition Principles
- Probability Activity
- Factorial Exploration
- Counting & Probability Test

**21st Century Skills**
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**Interdisciplinary Connections**

**Technology Integration**
- 8.1 Educational Technology- All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.
  - LCD Projector Document Camera
  - Laptop Computer
  - SmartBoard
Discrete Mathematics

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<tr>
<td>Topic</td>
<td>Matrices Revisited</td>
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</table>

**Essential Questions**

- How can a company that provides batteries for another company’s compact disc players be sure that it will have enough batteries on hand to fill orders?
- How does a fast-food chain determine prices that will allow it to do as well as possible against a competitor?
- How can a meteorologist use data about recent weather activity to predict the weather for tomorrow or a week from now?
- How can a park service use birth rates and survival rates of deer in managing herd populations?

**Enduring Understandings**

- The Leontief Input-Output Model
- Markov Chains
- Game Theory
- A Look at a Dominance Matrix

**Alignment to New Jersey Student Learning Standards**


**Key Concepts and Skills**

- Investigation of Leontief Input-Output Model
- Solve systems of equations with Matrices
- Explore Markov Chains
- Understand the Game Theory

**Learning Activities**

- Exploration of Supply & Demand (Input-Output Model)
- Game Theory Activity
- Historical Mathematician Project

**Assessments**

- Completing exercise questions
- Battery & Motor Division Problem
- Quiz on solving systems of equations
- Heads/Tails Activity
- Matrices Revisited Test

**21st Century Skills**

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**Interdisciplinary Connections**

- History

**Technology Integration**

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### Topic

Recursion

### Essential Questions

- How can recursion be used to create appealing images?
- How can recursion help people plan their financial futures?
- How can slight changes in recursive process change behavior from predictable to chaotic?

### Enduring Understandings

- Introduction to Recursive Thinking
- Finite Differences
- Arithmetic and Geometric Recursion
- Mixed Recursion
- Cobweb Diagrams
- Fractal Dimension

### Alignment to New Jersey Student Learning Standards

N-Q.1., F-BF.1., F-BF.2.

### Key Concepts and Skills

- Discussion on recursive thinking
- Explore finite differences
- Explore Arithmetic & Geometric Recursion
- Investigate mixed recursion (annuities)
- Discuss Cobweb Diagrams

### Learning Activities

- Handshake Activity
- Computer Project on Excel
- Calculator Activity on Sums of Arithmetic & Geometric Series
- College cost Project
- Annuity Exploration
- Sample Market investments
- Graphing Calculator Cobweb diagram exploration

### Assessments

- Completing exercise questions
- Quiz on recursion
- Computer exploration on recursion
- Quiz on finite differences
- Application problems on arithmetic & geometric information
- Recursion Test

### 21st Century Skills

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