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The Mathematics Department believes its students must learn the importance of mathematics, the integration of different branches of mathematics, the application of math to real-life problems, and the connections between mathematics and other disciplines. This course is concerned with developing the students' understanding of concepts that are not usually found in traditional high school courses and providing experience with its methods and applications in order to prepare students for study of higher mathematics.

This unit is an introduction to propositional logic. The rules of logic give precise meaning to mathematics statements. After examining the different types of statements and the notation that is used, truth tables will be constructed to determine under what conditions a statement can be classified as being true. Laws of logic, also known as rules of inference, will be investigated in order to determine whether an argument is valid. Incorrect forms of reasoning, called fallacies, will also be discussed.

	Course: Discrete Math **Grade: 11-12** **Unit: Logic** **Time Frame: 3 weeks**
CCSS Overarching Standards	Math.Practice.MP Standards for Mathematical Practice
Enduring Understanding	Reasoning is the key to logical arguments. The rules of logic specify the meaning of mathematical statements. The rules of inference prove a valid argument.
Essential Questions	What are statements? When is each type of compound statement true? How are the foundations of logical reasoning used to develop and prove conjectures? How are the laws of logic used to determine whether an argument is valid?
Priority Standards	Math.Practice.MP.3 Construct viable arguments and critique the reasoning of others
Performance Expectations	At the completion of this unit, students will be able to: • Identify statements and state their truth value. • Represent English-language statements using symbolic logic notation, and vice-versa.

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	• Use and interpret the validity of negations and compound statements (and, or, xor). • Use and interpret the validity of conditional statements (if…then) and equivalence (if and only if). • Identify the hypothesis and conclusion of a conditional statement. • Create truth tables to analyze the truth values of compound statements based on the truth values of their components. • Write the negation of conditional statements. • Determine if two statements are logically equivalent. • Use truth tables to identify tautologies and contradictions. • Write the converse, inverse, and contrapositive of conditional statements. • Recognize and use the rules of inference to prove the validity of arguments. • Explain why fallacies are invalid argument structures.

Strategies (examples)	**Materials/Resources (examples)**	**Assessments (examples)**
• Guided practice • Worksheets • Homework assignments • Cooperative group work • Better Lesson strategies (ex. Fill-the-Gap) • Quizzes • Tests • Projects • Computer activities	Discrete Math and Its Applications (Kenneth Rosen) Discrete Math (Richard Johnsonbaugh) Google sheets/Excel Online graph tool/probability calculator YouTube videos/Khan Academy	<u>Summative Assessments</u> Unit Tests Projects Portfolio Cumulative reviews Final Exam <u>Formative Assessments</u> Homework assignments Quizzes Exit slips Student discussion

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The concept of set, a collection of objects, is basic to all of mathematics and mathematical applications. This unit looks at the notation, types, and operations that can be created or formed from sets. Besides listing the objects in the sets, a graphical representation, or Venn diagram, will be created and used to determine how sets are formed and related. Set builder notation and the cardinality of sets will also be examined and used throughout the unit.

	Course: Discrete Math **Grade: 11-12** **Unit: Set Theory** **Time Frame: 2 weeks**
CCSS Overarching Standards	Math.Practice.MP Standards for Mathematical Practice
Enduring Understanding	A set is a collection of objects. Venn diagrams are a graphical representation of how elements of sets are related.
Essential Questions	What are sets? How are Venn diagrams used to show the relationship between sets? How are compound sets related to compound statements in logic?
Priority Standards	Math.Practice.MP.4 Reason abstractly and quantitatively
Performance Expectations	At the completion of this unit, students will be able to: • Represent a set using set-builder notation. • Give examples of finite and infinite sets. • Build new sets from existing sets using combinations of the set operations (intersection, union, difference, and complement). • Identify subsets of a given set. • State the cardinality of a set. • Determine whether two sets are equal by determining whether each is a subset of the other. • Use Venn diagrams to illustrate and investigate properties of set operations. • Apply the Inclusion-Exclusion Principle, for two and three sets, to determine the size of the union of sets. • Calculate and describe the Cartesian product of n sets. • Find the partition of a set satisfying given conditions. • Calculate and describe the power set for small sets. • Calculate the size of the Cartesian product of sets, and the power set of a set.

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The main topic of this unit is number theory, the branch of mathematics concerned with the integers. The concept of divisibility is reviewed and extended to factorization, greatest common divisors, and least common multiples. Modular arithmetic is examined so as to be able to identify whether two modulus expressions are congruent. Congruence is an important concept that is used in such applications as check digits and different cryptography systems.

	Course: Discrete Math **Grade: 11-12** **Unit: Number Theory** **Time Frame: 3 weeks**
CCSS Overarching Standards	HSN.RN The Real Number System
Enduring Understanding	Modular arithmetic is directly related to divisibility. Congruence exists between expressions that have a common remainder.
Essential Questions	How are divisibility and congruence related? What is modular arithmetic? How is divisibility in the form of 'mod' related to cryptography applications?
Priority Standards	HSN.RN.4 Use number theory arguments to justify relationships involving real numbers
Performance Expectations	At the completion of this unit, students will be able to: • Understand the concept and terminology related to division. • Use the Division Algorithm. • Write division statements in terms of 'mod' and 'div'. • Solve modular arithmetic problems. • Determine whether two expressions are congruent. • Know and use the Fundamental Theorem of Arithmetic, • Apply the Sieve of Eratosthenes to prime numbers. • Define and find greatest common divisors and least common multiples. • Use the Euclidean Algorithm to find greatest common divisors. • Write greatest common divisors as linear combinations. • Solve linear congruences.

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	• Find and verify check digits for a variety of uses (UPCs, ISBNs, postal money orders, airline tickets). • Encode and decode messages using different cryptography systems (Caesar cipher, shift cipher, RSA, Vigenere cipher).

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This unit examines several tools for counting, a crucial role in probability theory. Counting is the study of arrangements of objects. Many counting problems can be phrased in terms of ordered or unordered arrangements of objects, requiring the use of permutations and combinations. The Pigeonhole Principle, a specialized application of the counting principle, and the derivation and use of the binomial theorem are investigated.

	Course: Discrete Math **Grade: 11-12** **Unit: Counting** **Time Frame: 2 weeks**
CCSS Overarching Standards	S.CP Conditional Probability and the Rules of Probability
Enduring Understanding	Counting techniques can be used to find all of the possible ways to complete different tasks or choose items from a list. The counting principle can be an alternative for some combination and permutation situations. The rules for permutations apply to situations where the order of the tasks matters.
Essential Questions	How does the counting principle compare to combination and permutation calculations? How do counting methods relate to other areas of mathematics?
Priority Standards	S.CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.
Performance Expectations	At the completion of this unit, students will be able to: • Understand the product and sum rules for counting. • Derive the subtraction rule, also known as the principle of inclusion-exclusion. • Create tree diagrams to enumerate the number of possibilities in the sample space. • Determine the number of possible outcomes in a sample space by using the counting principle. • Apply the Generalized Pigeonhole Principle to problems. • Know the difference between permutations and combinations. • Use permutations and combinations to find the number of ways items can be grouped. • Use combinations to determine the coefficients of binomial expansions. • Examine Pascal's Triangle and explain how it relates to the Binomial Theorem.

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In this unit, the counting principles investigated in the last unit are expanded and used in situations involving probability. A review of basic probability is undertaken before studying cases of conditional probability. A specialized use of conditional probability, Bayes' Rule, is examined and applied to real-world problems. Binomial probabilities and means (averages) are also investigated since they are one of the most common discrete probability distributions.

	Course: Discrete Math **Grade: 11-12** **Unit: Discrete Probability** **Time Frame: 3 weeks**
CCSS Overarching Standards	S.CP Conditional Probability and the Rules of Probability S. MD Using Probability to Make Decisions
Enduring Understanding	Simple probability determines the likelihood of the occurrence of an event. A binomial distribution allows inferences to be made when there is a finite number of possible outcomes.
Essential Questions	How does the number of possible outcomes of an event affect a probability? What are the conditions of binomial probability distributions? How does Bayes' Rule involve conditional probability?
Priority Standards	S.CP.6 Find the conditional probability of A given B as the fractions of B's outcomes that also belong to A, and interpret the answer in terms of the model. S.CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems. S.MD.3 Develop a probability distribution for a random variable defined for a sample space in which probabilities are empirically; find the expected value.
Performance Expectations	At the completion of this unit, students will be able to: • Identify the sample space of a probability experiment and identify simple events. • Find the probability of the complement of an event and other probabilities using the Fundamental Counting Principle. • Distinguish between independent and dependent events. • Find conditional probabilities. • Understand and apply Bayes' Rule to real-life problems. • Identify a discrete random variable.

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	• Determine if a probability distribution is a binomial experiment. • Find binomial probabilities. • Find the mean, variance, and standard deviation of a binomial probability distribution.

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Graph theory, a relatively new field of mathematics, is the focus of this unit. Graphs are discrete structures consisting of vertices and edges that connect those vertices. After looking at the different properties and types of graphs, paths and circuits will be examined. Graph theory is applicable to many diverse uses, of which shortest-path and chromatic number problems will be investigated as they are related to business, consumer, and scheduling applications.

	Course: Discrete Math **Grade: 11-12** **Unit: Graphs** **Time Frame: 3 weeks**
CCSS Overarching Standards	HS. M Modeling HSN. VM Vector and Matrix Quantities
Enduring Understanding	Graphs are discrete structures consisting of vertices and edges that connect the vertices. Paths and circuits describe ways to trace around a graph. Graphs can be used in a wide variety of applications, such as networks and scheduling problems.
Essential Questions	What are graphs? What are the distinctions between different types of graphs? How do paths and circuits of a graph allow us to solve application problems?
Priority Standards	HSN.VM.6 Use matrices to represent and manipulate data HS.M Model real-world situations graphically.
Performance Expectations	At the completion of this unit, students will be able to: • Identify the different types of graphs. • Draw graphs that have specified characteristics or that model a given situation. • Recognize and determine the number of vertices, edges, and faces of a graph. • Identify the degree of a vertex and distinguish between in-degree and out-degree. • Determine whether a graph is bipartite. • Create graphs that are unions of two simple graphs. • Use adjacency lists and matrices to represent graphs. • Construct a graph from an adjacency matrix.

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	• Determine whether two simple graphs are isomorphic. • Identify whether a graph is connected. • Explain whether a directed graph is strongly or weakly connected. • Know the conditions for a graph to have an Euler path or Euler circuit. • Locate an Euler path or circuit within a graph. • Know and apply the definitions of Hamilton paths and circuits. • Locate a Hamilton path or circuit within a graph. • Apply Dijkstra's algorithm to find the shortest path in a directed graph and the length of the path. • Identify whether a graph is planar. • Draw a graph as a dual graph. • Apply the Four Color Theorem to determine the chromatic number of the graph.

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Trees form one of the most widely used subclasses of graphs. Trees are useful in relating data. After giving the requisite terminology, rooted trees and binary trees are examined. Applications of trees are then investigated in the form spanning trees, minimum spanning trees, and decision trees and related to real-world applications in diverse fields of study.

	Course: Discrete Math **Grade: 11-12** **Unit: Trees** **Time Frame: 2 weeks**
CCSS Overarching Standards	HS. M Modeling HSN. VM Vector and Matrix Quantities
Enduring Understanding	Trees are connected graphs that do not contain simple circuits. Trees can be used to show the relationship between items. When a tree has weighted edges, the shortest path can be found.
Essential Questions	How are trees and graphs related? What applications of graphs can also be done using trees?
Priority Standards	HSN.VM.6 Use matrices to represent and manipulate data HS.M Model real-world situations graphically.
Performance Expectations	At the completion of this unit, students will be able to: • Use appropriate vocabulary to identify the parts of trees. • Determine whether a tree is an m-ary tree. • Construct a binary search tree. • Use the sorting algorithm to find the required number of binary comparisons. • Perform tree traversals using preorder, inorde, and postorder traversals. • Apply traversals to application problems. • Know the definition of a spanning tree. • Use Breadth-first and Depth-first to create a spanning tree. • Apply Prim's algorithm to find a minimum spanning tree and determine its length.

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