



DISCRETE MATH B

Approved by KSD Board of Education: February 23, 2026

Course Description:

Students enrolled in this course will use rigorous thought and reasoning skills to explore areas of mathematics not traditionally covered in the algebra-precalculus-calculus sequence. Topics include secret codes and encryption, infinity and different levels of infinity, different geometries, topology, chaos and fractals and probability. Discrete mathematics lends itself to a wide variety of “real world” applications. Problems discussed will range from determining if there are two people on earth with the exact same number of hairs on their bodies to devising secret codes to examining the probability of winning the lottery.

Discrete Mathematics B is only offered in the second semester. Students do *not* have to take Discrete Mathematics A before taking Discrete Mathematics B.

Grade Level: 11th-12th

Unit Scope and Sequence

- Unit 1:** Problem Solving Revisited
- Unit 2:** Probability
- Unit 3:** Geometric Gems
- Unit 4:** Graph Theory
- Unit 5:** Topology
- Unit 6:** Flatland and Fourth Dimension
- Unit 7:** Number Bases

Course Enduring Understandings:

- Different branches of mathematics, such as geometry, probability, graph theory, topology, and number bases, are interconnected and can be applied to solve complex real-world problems.
- Engaging with abstract concepts—such as dimensions beyond three, higher number bases, and topological spaces—enhances critical thinking and problem-solving skills, enabling students to approach challenges from multiple perspectives.

Course Essential Questions:

- How do different branches of mathematics interrelate, and what insights can we gain from these connections?
- In what ways can abstract mathematical concepts, such as higher dimensions and alternative number systems, be visualized and understood?

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Unit 1: Problem Solving Revisited

In this unit, students will engage with a variety of puzzles designed to enhance their critical thinking and reasoning skills. The focus will be on both inductive and deductive reasoning as essential tools for problem-solving.

Unit 1 Essential Learning Targets	
<i>Enduring Understandings</i>	<i>Essential Questions</i>
• Problem-solving requires both inductive and deductive reasoning, and understanding when to apply each method enhances analytical skills. • The skills gained through solving puzzles are applicable to real-world scenarios, enhancing critical thinking in everyday decision-making and complex problem-solving situations.	• How do inductive and deductive reasoning differ, and how can each be applied effectively in problem-solving? • How can we evaluate the effectiveness of different problem-solving strategies in various contexts?
<i>Students must know:</i>	<i>Students must be able to:</i>
• Inductive Reasoning • Deductive Reasoning	• differentiate between inductive and deductive reasoning and select the appropriate method for a given problem. • analyze puzzles to identify underlying patterns and use those patterns to make logical inferences. • construct valid logical arguments using premises and conclusions, demonstrating sound deductive reasoning. • evaluate the effectiveness of various problem-solving strategies and justify their choices based on context.

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Unit 1: Problem Solving Revisited

Missouri Learning Standards

Standards for Mathematical Practice

- HS.MP.1 Make sense of problems and persevere in solving them.
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Unit 2: Probability

Through the application of the fundamental counting principle, students will determine the number of possible outcomes in a variety of scenarios, enhancing their ability to solve complex probability problems. They will also learn to calculate expected value, a key concept that helps in making informed decisions based on the likelihood and potential outcomes of various choices.

Unit 2 Essential Learning Targets

<i>Enduring Understandings</i>	<i>Essential Questions</i>
• Probability provides a framework for quantifying uncertainty and making informed decisions based on likelihood. • The concepts of independent and dependent events illustrate how the outcomes of one event can influence the outcomes of another. • The fundamental counting principle enables the determination of possible outcomes, essential for solving complex probability problems.	• How can we quantify the likelihood of an event occurring, and what factors influence these probabilities? • How does the fundamental counting principle help us solve complex probability problems? • What are the real-world applications of probability, and how can they impact our understanding of risk and reward?
<i>Students must know:</i>	<i>Students must be able to:</i>
• Probability • Event • Sample Space • Favorable Outcomes • Fundamental Counting Principle • Expected Value (EV) • Independent Events • Dependent Events • Conditional Probability • Prisoner's Dilemma • Misleading Statistics • Complementary Events • Random Experiment • Fair Game • Odds	• use the fundamental counting principle to determine the total number of possible outcomes in multi-step experiments. • calculate the expected value of a random variable to evaluate potential outcomes in various scenarios. • use probability concepts to analyze and identify misleading statistical representations in data. • distinguish between independent and dependent events and calculate their probabilities accurately.

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Unit 3: Geometric Gems

In this unit, students will explore geometry through the construction and analysis of various geometric figures. They will engage with different types of geometry, including Euclidean, spherical, taxi-cab, and hyperbolic geometry, developing a comprehensive understanding of their unique properties and applications.

Unit 3 Essential Learning Targets	
Enduring Understandings	Essential Questions
- Geometric frameworks have distinct properties that influence problem-solving approaches and applications. - Understanding the differences between Euclidean and non-Euclidean geometries broadens the comprehension of spatial relationships. - Construction of geometric figures is a vital skill that enhances visualization and understanding of geometric concepts. - Real-world scenarios can often be modeled using different types of geometry, each offering unique insights and solutions.	- What are the fundamental properties that distinguish Euclidean geometry from other types of geometry? - How can constructing geometric figures enhance our understanding of different geometric principles? - What real-world applications can we find for each type of geometry studied in this unit?
Students must know:	Students must be able to:
- Euclidean Geometry - Spherical Geometry - Taxi-Cab Geometry - Hyperbolic Geometry - Construct - Angle - Line Segment - Polygon - Circumference - Area - Volume - Non-Euclidean Geometry - Congruence - Similarity	- accurately construct geometric figures using appropriate tools and methods. - apply Euclidean geometric principles to solve various problems. - analyze and solve problems specific to spherical geometry. - apply the concepts of taxi-cab geometry to real-world scenarios. - engage with hyperbolic geometry to tackle complex problems. - articulate the differences and similarities between Euclidean, spherical, taxi-cab, and hyperbolic geometries.

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Unit 4: Graph Theory

In this unit, students will study graph theory by exploring its applications in various fields such as computer science, logistics, and social networks. Students will learn to identify key graph theory concepts, including vertices, edges, and paths. They will learn techniques for coloring maps using the vertex coloring algorithm and utilize the shortest route algorithm to determine optimal paths in networks. Additionally, students will create flowcharts to visualize processes and algorithms, enhancing their understanding of how graph theory can be applied in real-world situations.

Unit 4 Essential Learning Targets

<i>Enduring Understandings</i>	<i>Essential Questions</i>
- Graph theory provides a framework for understanding complex relationships and interactions within networks. - Map coloring techniques highlight the importance of efficient resource allocation and problem-solving in real-world applications. - Algorithms in graph theory, such as vertex coloring and shortest route algorithms, are essential tools for optimizing solutions in various fields.	- How can knowledge of graph theory be applied to new and unfamiliar situations, demonstrating its versatility and relevance? - What are the fundamental components of a graph, and how do they interact to form complex structures?
<i>Students must know:</i>	<i>Students must be able to:</i>
- Graph - Vertex - Edge - Path - Connected Graph - Degree of a Vertex - Map Coloring - Vertex Coloring Algorithm - Shortest Route Algorithm - Flowchart - Directed Graph - Weighted Graph - Tree - Network - Hamiltonian Path	- identify and explain key concepts in graph theory, including vertices, edges, and paths. - apply map coloring techniques to create a color-coded representation of a graph. - utilize the vertex coloring algorithm to solve graph coloring problems effectively. - implement the shortest route algorithm to determine optimal paths in given scenarios. - design flowcharts that represent processes and algorithms related to graph theory.

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Unit 4: Graph Theory

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Unit 5: Topology

In this unit, students will explore topology, focusing on its fundamental concepts and real-world applications. They will learn to identify key topological ideas such as continuity, compactness, and connectedness, which form the foundation of this mathematical discipline.

Unit 5 Essential Learning Targets	
Enduring Understandings	Essential Questions
- Topology provides a unique perspective on the properties of space, emphasizing continuity and connectedness over rigid geometric measurements. - Understanding key topological concepts is essential for exploring more advanced mathematical ideas and their applications. - Topological puzzles serve as effective tools for developing critical thinking and problem-solving skills, illustrating abstract concepts in an engaging way.	- What are the key concepts in topology, and how do they differ from traditional geometric concepts? - How does the idea of continuity play a crucial role in the study of topological spaces? - In what ways can topological puzzles enhance our understanding of complex mathematical ideas?
Students must know:	Students must be able to:
- Topology - Topological Space - Open Set - Closed Set - Continuity - Homeomorphism - Compactness - Connectedness - Basis of a Topology - Topological Invariance - Euler Characteristic - Klein Bottle - Möbius Strip - Torus - Topological Puzzle	- identify and explain key concepts in topology, including open and closed sets, continuity, and compactness. - engage with and solve various topological puzzles, applying their understanding of topological principles. - analyze and describe different types of topological spaces and their properties. - assess whether two given topological spaces are homeomorphic and justify their reasoning. - apply topological concepts to solve problems and make connections to real-world scenarios.

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Unit 5: Topology

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Unit 6: Flatland and the Fourth Dimension

In this unit, students will study the implications of the fourth dimension, discussing its mathematical significance and its representation in various fields, including physics and art. Students will gain a deeper understanding of dimensionality, ultimately enhancing their spatial reasoning and critical thinking skills.

Unit 6 Essential Learning Targets	
Enduring Understandings	Essential Questions
- The concept of the fourth dimension expands our understanding of space and challenges traditional perceptions of reality. - Exploring dimensions beyond three provides valuable insights into the nature of mathematical and physical concepts. - Visualizing higher dimensions requires creative thinking and can be expressed through various forms, including art and mathematics.	- How does the concept of the fourth dimension challenge our understanding of spatial dimensions? - In what ways can we visualize and represent the fourth dimension mathematically and artistically?
Students must know:	Students must be able to:
- Dimension - Flatland - Fourth Dimension - Spatial Reasoning - Hyperspace - Tesseract - Projection - Perception - Geometry - Coordinate System - Non-Euclidean Geometry - Mathematical Visualization - Abstract Concept - Hypercube - Cross-section	- articulate what the fourth dimension is and how it differs from the three dimensions we experience daily. - create visual representations of the fourth dimension, including concepts like the tesseract or hypercube. - explain the significance of the fourth dimension in the context of physics, particularly in theories of space and time. - apply their understanding of the fourth dimension to solve problems or create projects that demonstrate higher-dimensional thinking.

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Unit 6: Flatland and the Fourth Dimension

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Unit 7: Number Bases

In this unit, students will explore the concept of number bases, focusing on the representation and manipulation of numbers in various bases beyond the familiar base ten system. Students will learn how to convert numerals between different bases, including binary, octal, and hexadecimal. Students will develop a deeper understanding of how different number systems work and their applications in computer science, mathematics, and real-world scenarios.

Unit 7 Essential Learning Targets

<i>Enduring Understandings</i>	<i>Essential Questions</i>
- Understanding number bases enhances mathematical literacy and provides insight into the structure of various numeral systems. - Converting between different bases is a fundamental skill that applies to many fields, including computer science and digital technology. - Operations in various bases require a solid grasp of place value and the ability to adapt traditional arithmetic methods.	- How do we convert numbers from one base to another, and why is this important in mathematics and computer science? - What methods can be used to perform arithmetic operations in bases other than decimal? - How do place value systems function in different bases, and what challenges do they present? - In what real-world applications are different number bases utilized, particularly in technology and computing?
<i>Students must know:</i>	<i>Students must be able to:</i>
- Base - Numeral System - Decimal (Base 10) - Binary (Base 2) - Octal (Base 8) - Hexadecimal (Base 16) - Conversion - Place Value - Digits - Arithmetic Operations - Overflow - Radix - Subscript - Bit - Byte	- convert numerals from decimal to other bases (binary, octal, hexadecimal) and vice versa. - carry out addition, subtraction, multiplication, and division in various bases. - explain how place value works in different bases and its significance in numeral representation. - solve problems that involve converting and performing operations across different numeral systems. - apply their understanding of number bases to real-world scenarios, particularly in computing and technology.

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