

# HISD | Secondary Curriculum and Development

ALIGN, ADVANCE, ENGAGE.  
2021-2022 Scope and Sequence  
Mathematics – Discrete Mathematics for Problem Solving

## Course Design

In Discrete Mathematics for Problem Solving, students are introduced to the improved efficiency of mathematical analysis and quantitative techniques over trial-and-error approaches to management problems involving organization, scheduling, project planning, strategy, and decision making. Students will learn how mathematical topics such as graph theory, planning and scheduling, group decision making, fair division, game theory, and theory of moves can be applied to management and decision making. Students will research mathematicians of the past whose work is relevant to these topics today and read articles about current mathematicians who either teach and conduct research at major universities or work in business and industry solving real-world logistical problems. Through the study of the applications of mathematics to society's problems today, students will become better prepared for and gain an appreciation for the value of a career in mathematics.

Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

The prerequisite for enrollment in Discrete Mathematics is Algebra II.

Cycle 1	27 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Aug. 23 - Oct. 1, 2021	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
		<p><i>The Mathematical Process Standards are integrated throughout the course in all activities and lessons. Teachers should refer to these standards for instructional strategies and depth of rigor.</i></p> <p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓟ <b>DMPS.1B</b> Use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution.</li> <li>Ⓟ <b>DMPS.1C</b> Select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems.</li> <li>Ⓟ <b>DMPS.1D</b> Communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate.</li> <li>Ⓟ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1G</b> Display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.</li> </ul>

## GLOBAL GRADUATE



Ⓟ - State Process Standard

Ⓜ - Aligned to Upcoming State Readiness Standard

Ⓡ - State Readiness Standard

Ⓢ - State Supporting Standard

© Houston ISD Curriculum  
2021-2022

Page 1 of 10

Cycle 1	27 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Aug. 23 - Oct. 1, 2021	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<p><b>Unit 1: Introduction to Graph Theory</b> Students explore the relationships among lines and points without regard to position or length.</p>	<p>4 class periods (90-min. each) or 8 class periods (45-min. each)</p> <p><i>Enrichment Opportunities</i> Aug. 2-13</p> <p><i>Teachers Report to Work</i> Aug. 16</p> <p><i>Teacher Service Days</i> Aug. 16-17, Aug. 19-20</p> <p><i>Teacher Prep Day</i> (no students) Aug. 18</p> <p><i>Labor Day</i> Sept. 6</p> <p><i>Fall Holiday</i> Sept. 16</p> <p><i>Teacher Service Day</i> (no students) Sept. 17</p>	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓡ <b>DMPS.1C</b> Select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems.</li> <li>Ⓡ <b>DMPS.1G</b> Display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.</li> </ul> <p><b>Graph theory.</b> The student applies the concept of graphs to determine possible solutions to real-world problems. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.2A</b> Explain the concept of graphs.</li> <li>• <b>DMPS.2B</b> Use graph models for simple problems in management science.</li> <li>• <b>DMPS.2C</b> Determine the valences of the vertices of a graph.</li> <li>• <b>DMPS.2L</b> Explain the difference between a graph and a directed graph.</li> </ul>

Cycle 1	27 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Aug. 23 - Oct. 1, 2021	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<b>Unit 2: Eulerian Graphs</b> Students investigate Eulerian graphs and their applications.	3 class periods (90-min. each) or 6 class periods (45-min. each)	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1D</b> Communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate.</li> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> </ul> <p><b>Graph theory.</b> The student applies the concept of graphs to determine possible solutions to real-world problems. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.2D</b> Identify Euler circuits in a graph.</li> <li>• <b>DMPS.2E</b> Solve route inspection problems by Eulerizing a graph.</li> <li>• <b>DMPS.2F</b> Determine solutions modeled by edge traversal in a graph.</li> <li>• <b>DMPS.2G</b> Compare the results of solving the traveling salesman problem (TSP) using the nearest neighbor algorithm and using a greedy algorithm.</li> <li>• <b>DMPS.2H</b> Distinguish between real-world problems modeled by Euler circuits and those modeled by Hamiltonian circuits.</li> <li>• <b>DMPS.2I</b> Distinguish between algorithms that yield optimal solutions and those that give nearly optimal solutions.</li> <li>• <b>DMPS.2L</b> Explain the difference between a graph and a directed graph.</li> </ul>
<b>Unit 3: Simple Graphs (Trees)</b> Students examine applications of simple graphs (trees).	4 class periods (90-min. each) or 8 class periods (45-min. each)	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> </ul> <p><b>Graph theory.</b> The student applies the concept of graphs to determine possible solutions to real-world problems. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.2J</b> Find minimum-cost spanning trees using Kruskal's algorithm.</li> <li>• <b>DMPS.2K</b> Use the critical path method to determine the earliest possible completion time for a collection of tasks.</li> <li>• <b>DMPS.2L</b> Explain the difference between a graph and a directed graph.</li> </ul>

Cycle 2	29 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Oct. 5 - Nov. 12, 2021	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<b>Unit 4: Planning and Scheduling</b> Students examine methods and algorithms to optimize project scheduling.	6 class periods (90-min. each) or 12 class periods (45-min. each)  <i>Teacher Service Day (no students) Oct. 4</i>	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓟ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> </ul> <p><b>Planning and scheduling.</b> The student uses heuristic algorithms to solve real- world problems. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.3A</b> Use the list processing algorithm to schedule tasks on identical processors.</li> <li>• <b>DMPS.3B</b> Recognize situations appropriate for modeling or scheduling problems.</li> <li>• <b>DMPS.3C</b> Determine whether a schedule is optimal using the critical path method together with the list processing algorithm.</li> <li>• <b>DMPS.3G</b> Explain the relationship between scheduling problems and bin packing problems.</li> </ul>
<b>Unit 5: Packing Optimization Applications</b> Students examine methods and algorithms to optimize packing problems.	6 class periods (90-min. each) or 12 class periods (45-min. each)	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> </ul> <p><b>Planning and scheduling.</b> The student uses heuristic algorithms to solve real-world problems. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.3D</b> Identify situations appropriate for modeling by bin packing.</li> <li>• <b>DMPS.3E</b> Use any of six heuristic algorithms to solve bin packing problems.</li> <li>• <b>DMPS.3F</b> Solve independent task scheduling problems using the list processing algorithm.</li> <li>• <b>DMPS.3G</b> Explain the relationship between scheduling problems and bin packing problems.</li> </ul>

Cycle 3	30 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Nov. 15, 2021 - Jan. 14, 2022	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<b>Unit 6: Group Decision Making</b> Students apply mathematical decision-making models to weighted voting systems to evaluate and compare election procedures.	<b>10</b> class periods (90-min. each) or <b>20</b> class periods (45-min. each)  <i>Thanksgiving Break</i> Nov. 22-26  <i>Enrichment Opportunities</i> Dec. 20-21  <i>Winter Break</i> Dec. 20-31  <i>MLK Jr. Day</i> Jan. 17  <i>Teacher Prep Day</i> <i>(no students)</i> Jan. 18	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓟ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1G</b> Display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.</li> </ul> <p><b>Group decision making.</b> The student uses mathematical processes to apply decision-making schemes. The student analyzes the effects of multiple types of weighted voting and applies multiple voting concepts to real-world situations. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.4A</b> Describe the concept of a preference schedule and how to use it.</li> <li>• <b>DMPS.4B</b> Explain how particular decision-making schemes work.</li> <li>• <b>DMPS.4C</b> Determine the outcome for various voting methods, given the voters' preferences.</li> <li>• <b>DMPS.4D</b> Explain how different voting schemes or the order of voting can lead to different results.</li> <li>• <b>DMPS.4E</b> Describe the impact of various strategies on the results of the decision-making process.</li> <li>• <b>DMPS.4F</b> Explain the impact of Arrow's Impossibility Theorem.</li> <li>• <b>DMPS.4G</b> Relate the meaning of approval voting.</li> <li>• <b>DMPS.4H</b> Explain the need for weighted voting and how it works.</li> <li>• <b>DMPS.4I</b> Identify voting concepts such as Borda count, Condorcet winner, dummy voter, and coalition.</li> <li>• <b>DMPS.4J</b> Compute the Banzhaf power index and explain its significance.</li> </ul>

Cycle 4	27 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Jan. 19 - Feb. 25, 2022	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<b>Unit 7: Fair Division</b> Students apply fair division and distribution methods in a variety of allocation scenarios.	<b>11</b> class periods (90-min. each) or <b>22</b> class periods (45-min. each)  <i>Teacher Service Day/Presidents' Day (no students) Feb. 21</i>	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓡ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓡ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> <li>Ⓡ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> </ul> <p><b>Fair division.</b> The student applies the adjusted winner procedure and Knaster inheritance procedure to real-world situations. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.5A</b> Use the adjusted winner procedure to determine a fair allocation of property.</li> <li>• <b>DMPS.5B</b> Use the adjusted winner procedure to resolve a dispute.</li> <li>• <b>DMPS.5C</b> Explain how to reach a fair division using the Knaster inheritance procedure.</li> <li>• <b>DMPS.5D</b> Solve fair division problems with three or more players using the Knaster inheritance procedure.</li> <li>• <b>DMPS.5E</b> Explain the conditions under which the trimming procedure can be applied to indivisible goods.</li> <li>• <b>DMPS.5F</b> Identify situations appropriate for the techniques of fair division.</li> <li>• <b>DMPS.5G</b> Compare the advantages of the divider and the chooser in the divider- chooser method.</li> <li>• <b>DMPS.5H</b> Discuss the rules and strategies of the divider-chooser method.</li> <li>• <b>DMPS.5I</b> Resolve cake-division problems for three players using the last diminisher method.</li> <li>• <b>DMPS.5J</b> Analyze the relative importance of the three desirable properties of fair division: equitability, envy-freeness, and Pareto optimality.</li> <li>• <b>DMPS.5K</b> Identify fair division procedures that exhibit envy-freeness.</li> </ul>

Cycle 5	33 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Feb. 28 - Apr. 22, 2022	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<b>Unit 8: Introduction to Game Theory</b> Students explore introductory competition theory to represent optimal strategies.	7 class periods (90-min. each) or 14 class periods (45-min. each)  <i>Enrichment Opportunities</i> <i>Mar. 14-16</i>  <i>Spring Break</i> <i>Mar. 14-18</i>  <i>Chávez-Huerta Day</i> <i>Mar. 28</i>  <i>Spring Holiday</i> <i>Apr. 15</i>	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓟ <b>DMPS.1B</b> Use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution.</li> <li>Ⓟ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> </ul> <p><b>Game (or competition) theory.</b> The student uses knowledge of basic game theory concepts to calculate optimal strategies. The student analyzes situations and identifies the use of gaming strategies. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.6A</b> Recognize competitive game situations.</li> <li>• <b>DMPS.6B</b> Represent a game with a matrix.</li> <li>• <b>DMPS.6C</b> Identify basic game theory concepts and vocabulary.</li> <li>• <b>DMPS.6D</b> Determine the optimal pure strategies and value of a game with a saddle point by means of the minimax technique.</li> <li>• <b>DMPS.6E</b> Explain the concept of and need for a mixed strategy.</li> </ul>

Cycle 5		33 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
		Feb. 28 - Apr. 22, 2022	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:	
<p><b>Unit 9: Applications of Game Theory</b> Students apply competition theory to model and calculate optimal strategies in a variety of game scenarios.</p>	<p>6 class periods (90-min. each) or 12 class periods (45-min. each)</p>	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓡ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓡ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> </ul> <p><b>Game (or competition) theory.</b> The student uses knowledge of basic game theory concepts to calculate optimal strategies. The student analyzes situations and identifies the use of gaming strategies. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.6F</b> Compute the optimal mixed strategy and the expected value for a player in a game who has only two pure strategies.</li> <li>• <b>DMPS.6G</b> Model simple two-by-two, bimatrix games of partial conflict.</li> <li>• <b>DMPS.6H</b> Identify the nature and implications of the game called "Prisoners' Dilemma".</li> <li>• <b>DMPS.6I</b> Explain the game known as "chicken".</li> <li>• <b>DMPS.6J</b> Identify examples that illustrate the prevalence of Prisoners' Dilemma and chicken in our society.</li> <li>• <b>DMPS.6K</b> Determine when a pair of strategies for two players is in equilibrium.</li> </ul>	



Cycle 6	31 Days	The recommended number of class periods is less than the number of days in the grading cycle to accommodate differentiated instruction, extended learning time, and assessment days. Complete instructional planning information and support are in the HISD Curriculum documents.
	Apr. 25 - June 7, 2022	
Unit	# Class Periods	Texas Essential Knowledge and Skills/Student Expectations (TEKS/SEs) The student will:
<b>Unit 10: Theory of Moves</b> Students investigate moves and countermoves within a strategic scenario to analyze, model, and plan the nature of a conflict over time.	<b>10</b> class periods (90-min. each) or <b>20</b> class periods (45-min. each)  <i>Memorial Day</i> <i>May 30</i>  <i>Teacher Prep Day</i> <i>(no students)</i> <i>June 8</i>	<p><b>Mathematical Process Standards.</b> The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:</p> <ul style="list-style-type: none"> <li>Ⓟ <b>DMPS.1A</b> Apply mathematics to problems arising in everyday life, society, and the workplace.</li> <li>Ⓟ <b>DMPS.1C</b> Select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems.</li> <li>Ⓟ <b>DMPS.1E</b> Create and use representations to organize, record, and communicate mathematical ideas.</li> <li>Ⓟ <b>DMPS.1F</b> Analyze mathematical relationships to connect and communicate mathematical ideas.</li> </ul> <p><b>Theory of moves.</b> The student analyzes the theory of moves (TOM). The student uses the TOM and game theory to analyze conflicts. The student is expected to:</p> <ul style="list-style-type: none"> <li>• <b>DMPS.7A</b> Compare and contrast TOM and game theory.</li> <li>• <b>DMPS.7B</b> Explain the rules of TOM.</li> <li>• <b>DMPS.7C</b> Describe what is meant by a cyclic game.</li> <li>• <b>DMPS.7D</b> Use a game tree to analyze a two-person game.</li> <li>• <b>DMPS.7E</b> Determine the effect of approaching Prisoners' Dilemma and chicken from the standpoint of TOM and contrast that to the effect of approaching them from the standpoint of game theory.</li> <li>• <b>DMPS.7F</b> Describe the use of TOM in a larger, more complicated game.</li> <li>• <b>DMPS.7G</b> Model a conflict from literature or from a real-life situation as a two-by-two strict ordinal game and compare the results predicted by game theory and by TOM.</li> </ul>

## Recommended Resources

### Graphing Technology:

- [Desmos](#) – a free graphing program
- [GeoGebra](#) – a free and multi-platform dynamic mathematics software involving multiple representations for all levels of mathematics including geometry, algebra, statistics, and calculus
- [TI-84+/TI-nspire Education Technology](#) – calculator activities for use in this course as a discovery and analytical tool

### Adopted Instructional Materials:

- Pearson, *Algebra 1*
- OpenStax, *Algebra 2*

### Online Resources:

(NOTE: for additional web 2.0 tools, access HISD [Instructional Technology Web Tools](#))

- [AnalyzeMath](#) – an interactive applet with definitions, examples, and practice exercises
- [Bubbl.us](#) – a tool for creating graphic organizers and mind maps
- [Creately](#) – a Venn diagram maker
- [Edmodo](#) – a social communication platform
- [Khan Academy](#) – instructional videos and practice exercises
- [Math Warehouse](#) – definitions, examples, and practice exercises
- [Math Open Reference](#) – free interactive mathematics textbook
- [NCTM Illuminations](#) – interactive activities
- [OnlineMathLearning](#) – mathematics help and learning resources
- [Padlet](#) – a tool for classroom collaboration
- [Problem-attic](#) – 100,000 questions from NY Regents, State Assessments, Academic Competitions
- [Purple Math](#) – tutorial guides
- [Socrative](#) – interactive games and exercises
- [StudyStack](#) – study aids for vocabulary
- [TeacherTube](#) – instructional videos
- [Virtual Nerd](#) – instructional videos
- [Wolfram Demonstrations Project](#) – an application for mathematics investigations
- [YouTube](#) – instructional videos