Grade(s):	**11 & 12**
Discipline/Course:	**Mathematics**
Course Title:	**Modern Mathematics - B**
Prerequisite(s):	Algebra 2
Course Description: *Program of Studies*	Modern Mathematics is a fourth-year launch course that differs from the courses that precede it in that the mathematics is focused on discrete topics instead of continuous functions. This post-Algebra II course is heavily based in modeling with mathematics and includes topics like elections and weighted voting, graph theory, game theory, and apportionment. Students engage in problem-based learning where problems are ill defined and may have varying outcomes. In this course, reasoning and modeling are primary drivers of instruction.
Course Essential Questions:	**Where is mathematics used?** **What is the mathematics connection to history, art, computer science, etc?**
Course Enduring Understandings:	● A quantity can be represented numerically in various ways. ● Problem solving depends upon choosing wise ways. ● There are multiple algorithms for finding a solution.
Duration:	Semester
Course Materials/Resources:	Excursions in modern mathematics (9th), Peter Tannenbaum, Pearson

***Note: Topics listed in the units may evolve over time based on adaptations to implementation. However, the overall content of the entire course will not change**

Academic Expectations The Fairfield Public Schools describe a variety of cross curricular expectations that all students should exemplify during their time within the schooling experience. This page gives examples of what the practice standards look like at the specified grade level. Students are expected to:		
Standards	Explanations	Example
1. Exploring and Understanding	When students engage in problem solving situations, they should be able to understand the problem, determine relevant information, and ask relevant additional questions.	Students should be able to answer the following questions when approaching a problem: 1. Do you understand all the words used in stating the problem? 2. What are you asked to find or show? 3. Can you restate the problem in your own words? 4. Can you think of a picture or diagram that might help you understand the problem?
2. Synthesizing and Evaluating	Engaging in a problem solving situation, students should be able to analyze the most efficient approach, and reflect on the process used to solve the problem.	Students should be able to answer the following questions when analyzing how to approach a problem, and also reflect on the result: 1. Is there enough information to enable you to find a solution? If not, what additional information is needed? 2. Are there multiple ways to complete the task? Which approach do you think is most efficient, and why? 3. Do you know a related problem? Look at the unknown and try to think of a familiar problem having the same or similar unknown. Can you use it? 4. Was your strategy effective? What worked? What didn't? 5. Was there another approach that could have been more efficient? 6. Is your answer reasonable? How do you know? 7. Was your presentation approach effective? If not, what would you change? 8. How did the communication tools allow you to get the message across to the intended audience?

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3. Creating and Constructing	Engaged in a problem solving situation, students should implement a plan.	Students should be able to answer the following question to implementing their plan to solve a problem: 1. What strategy will you use to complete the task?
4. Conveying Ideas	Students should be able to use correct mathematical language, logically display their work for the desired problem.	Students should be able to answer the following questions to convey their mathematical thinking to solve a problem: 1. How will you present your information to your intended audience? 2. Does your response illustrate the correct terms and work to the problem?
5. Using Communication Tools	Students should be able to choose the correct tools to illustrate their mathematical work to solve a specific problem.	Students should be able to answer the following question to use specific communication tools to solve a problem: 1. If applicable, what communication tools will you use to convey your ideas and solution?
6. Collaborating Strategically	Students should be able to work collaboratively to solve problems.	Students should be able to answer the following question to collaboratively solve problems: 1. In what ways did you work together to help solve the desired problem?

Unit Number and Title:	**Unit 1: The Mathematics of Paths and Touring (Euler Paths and Circuits, Traveling Salesman Problems, & The Cost of Being Connected)**
Resource(s):	Textbook: Chapter 5 Textbook: Chapter 6 Textbook: Chapter 7
Learning Goals	
Standard(s):	CC 2.3.HS.A.14: Apply geometric concepts to model and solve real world problems CC.2.3.HS.A.13: Analyze relationships between two-dimensional and three dimensional objects CC 2.3.HS.A.2: Apply rigid transformations to determine and explain congruence
Essential Question(s):	● What is the difference between a path and a circuit? ● What distinguishes an Euler path or circuit from a Hamilton path or circuit? ● What types of real-world problems can be solved by Euler algorithms? ● What types of real-world problems can be solved by Hamilton algorithms? ● Why would a problem solver choose one algorithm over the other?
Enduring Understanding(s):	● Maneuvering around the real world requires math. ● The difference between trips and tours in real world logistics. ● Real world logistics is really moving through a network.
Learning Goal(s): *Students will be able to use their learning to:*	Students will be able to: 1. Define a graph as a set of vertices together with a set of edges 2. Define the essential vocabulary associated with graph theory; adjacent, degree, paths, circuits, connected graphs, and bridges 3. Find the valence of each vertex in a graph 4. Represent the vertices and edges of a graph as an adjacency matrix, and use the matrix to solve problems. 5. Investigate and describe valence and connectedness 6. Determine whether a graph is planar or non-planar

	7. Determine every planar graph has a chromatic number that is less than or equal to four based on the four-color-map theorem 8. Apply the four-color map theorem to multiple maps 9. Define the following vocabulary words: tree, spanning tree, shortest network, network, minimum spanning tree 10. Use Kruskal's, Prim's and Dijkstra's algorithm to find the shortest spanning tree 11. Determine the degree of each of the vertices in a directed graph (digraph) as well as the in-degree and out-degree 12. Model projects consisting of several subtasks 13. Identify the critical path to determine the earliest completion of time (minimum project time) 14. Solve scheduling problems with critical path algorithms 15. Explore the differences between a path and a circuit 16. Determine if a graph has an Euler path or circuit and find one if either exists 17. Apply the Euler Circuit algorithm to solve optimization problems 18. Determine if a graph has a Hamilton path or Circuit and find one if either exists 19. Count the number of Hamilton Circuits for a complete graph with *n* vertices. 20. Determine the number of edges in a complete graph 21. Compare and contrast the differences between Euler and Hamilton 22. Define the different types of algorithms that exist; optimal, inefficient, efficient and approximate 23. Calculate the optimal solutions to graphs and charts that have Hamilton circuits using one of the following algorithms: Brute-Force, Nearest Neighbor, Repetitive Nearest Neighbor, and Cheapest Link

Unit Number and Title:	**Unit 2: The Mathematics of Scheduling: Chasing the Critical Path**
Resource(s):	Textbook: Chapter 8
Learning Goals	
Standard(s):	A.CED.1: Create equations and inequalities in one variable and use them to solve problems.
Essential Question(s):	● Will increasing the number of processors decrease completion time? ● Will the decreasing time list algorithm guarantee an optimal solution? ● What situations can be best modeled using order-requirement digraphs or a machine scheduling problem? ● What is the maximum number of colors needed to color any map? How can the vertex coloring algorithm be applied to resolve conflict?
Enduring Understanding(s):	● Every scheduler's dream: the "best" path through a network
Learning Goal(s): *Students will be able to use their learning to:*	1. Schedule task on two or three "machines" 2. Create critical paths 3. schedule independent tasks 4. Find efficient ways to pack "bins" 5. Solve conflict using colors 6. Solve scheduling problems by: a. Determining precedence relations. b. Creating a priority list. c. Creating a project digraph. d. Using one or more processors or workers. 7. Optimize solutions via the:

	a. Decreasing Time algorithm. b. Critical Path algorithm 8. Discuss the efficiency of these algorithms.

Unit Number and Title:	**Unit 3: Fractals**
Resource(s):	Textbook: Chapter 12
[redacted]	
Standard(s):	CCSS.MATH.CONTENT.HSG.MG.A.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder). CCSS.MATH.CONTENT.HSG.MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). CCSS.MATH.CONTENT.HSG.SRT.A.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides
Essential Question(s):	• What is a fractal? • Where can you find one in nature? • How can you create fractals?
Enduring Understanding(s):	• The simple, yet complex, similarities of nature: Fractals.
Learning Goal(s): *Students will be able to use their learning to:*	1. Understand the geometry, representation, and vast application of fractals embedded in broccoli, clouds, coastlines, arteries, antennas, movie backgrounds, and other applications. 2. Express the contributions to the field of famous mathematicians Mandelbrot, Cantor, Koch, and Sierpinski to name a few.

	3. Draw a fractal given an initiator & generator. 4. Use technology to generate fractal iterations. 5. Write explicit and recursive formulae for measurements of fractals. 6. Determine the fractal dimension of objects as a measure of roughness

Unit Number and Title:	**Unit 4: Fibonacci Numbers and the Golden Ratio**
Resource(s):	Textbook: Chapter 13
Learning Goals	
Standard(s):	CCSS.MATH.CONTENT.HSF.IF.A.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
Essential Question(s):	● What are Fibonacci Numbers? ● How does is a fibonacci sequence used in the "real world?"
Enduring Understanding(s):	● Recursive sequences, the golden ratio, and their ubiquitous nature
Learning Goal(s): *Students will be able to use their learning to:*	1. Use and solve problems with the Fibonacci sequence and other recursive sequences. 2. Use the Fibonacci sequence to develop the Golden Ratio. 3. Discover Fibonacci patterns in nature. 4. Explain Fibonacci Numbers and their origin. 5. Generate the next numbers in a Fibonacci sequence. 6. Recursive sequences, the golden ratio, and their ubiquitous nature