

Mathematical Modeling (MATX) CTY Course Syllabus

STUDENT EXPECTATIONS

Welcome Students! You are about to engage in a fun and exciting journey through some difficult terrain. Your only compass? That section of your brain responsible for your mathematical reasoning! You will be exposed to math in a context you have probably never seen before. We will be using math to represent ideas in various different fields as well as help to us understand complicated systems. Fear not! If you follow along and give your best effort (which I demand from each and every one of you WITH NO EXCEPTIONS) you will find that this journey will help you grow into a better thinker and an overall better individual.

DAY TO DAY SCHEDULE

DAY	SESSION	TOPIC COVERED/WORK DONE
1 (Monday)	Morning	<u>Introductions</u> <ul style="list-style-type: none"> Rules & Regulations (Honor Code, cheating, plagiarism, no taking books out of class) Administer the Pre-Test Writing activity: what do you think math modeling is? Share aloud
	Afternoon	<u>Introduction to Ray Tracing</u> <ul style="list-style-type: none"> Lecture on how light travels through a thin lens, and how it bends. Students use ray tracing technique to show how images are formed on a worksheet
	Evening	<u>The Thin Lens Equation</u> <ul style="list-style-type: none"> Lesson on solving non-linear equations Relationship between object, image and focal distances
2 (Tuesday)	Morning	<u>Measuring the Thin Lens Equation</u> <ul style="list-style-type: none"> Experiment to confirm the Thin Lens Equation and any prediction that can be made with it
	Afternoon	<u>Introduction to Probability</u> <ul style="list-style-type: none"> Definition of probability Simple events, compound events, independent versus dependent events Introduction to histogram and finding the probability of an outcome with two dice

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	Evening	<u>Implications of probability:</u> <ul style="list-style-type: none"> Finding the probability of winning the lottery and why most games of chance will ultimately result in loss Probability that everyone in room will spontaneously choke to death
3 (Wednesday)	Morning	<u>Empirical Probability Versus Theoretical Probability</u> <ul style="list-style-type: none"> Frequency chart for a pair of dice being thrown Finding the probability of the outcomes for the “strange” Sicherman Dice
	Afternoon	<u>Monty Hall Problem</u> <ul style="list-style-type: none"> Student simulation of Monty Hall problem with cups and chocolate bars Creating frequency charts to track wins and losses in simulation Discover best strategy to use in Monty Hall problem
	Evening	<u>Probability Problems</u> <ul style="list-style-type: none"> Textbook problems from Tannenbaum
4 (Thursday)	Morning	<u>Graphics and Lines Project</u> <ul style="list-style-type: none"> Introduction to linear equations, defining slope and y-intercept of a line Creating line segments using domain of a line, identifying domain of a segment Students create a sample graphic using principles above
	Afternoon	<u>Creating Graphics (Computer Lab)</u> <ul style="list-style-type: none"> Students reproduce their graphic using Geometer’s Sketchpad
	Evening	<u>Introductions to Imaginary Numbers</u> <ul style="list-style-type: none"> Define imaginary, discuss properties of i. Plotting complex numbers on the imaginary plane “Guess Who Said This” activity worksheet
5 (Friday)	Morning	<u>Discrete Sums</u> <ul style="list-style-type: none"> Finding sum of consecutive integers Geometric Series, Consecutive Squares Applications of Sums

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	Afternoon	<u>Recap of Sums:</u> <ul style="list-style-type: none"> Worksheet overview of the sums considered in class
6 (Sunday)	Evening	<u>Fermat's Last Theorem</u> <ul style="list-style-type: none"> Documentary that chronicles Andrew Wiles proof of Fermat's Last Theorem
7 (Monday)	Morning	<u>Statistics – What can we infer from Data? How do we compare data?</u> <ul style="list-style-type: none"> A look at various scenarios where data intends to mislead the reader Students Determine what information can be concluded from data Make their own misleading data!
	Afternoon	<u>Measures of Central Tendency: Mean, Median, Mode</u> <ul style="list-style-type: none"> Give each student a bag of M&M's. Have them write a frequency chart, and create a Stem & Leaf plot with the data collected from there M&M's. Bring the class together, make a full frequency chart, bar graph, histogram, and Box & Whisker Plot.
	Evening	<u>Survey Questions:</u> <ul style="list-style-type: none"> Students Create a Survey on a Given topic Where They Ask 5 multiple choice questions with numeric answers and compile answers to make charts.
8 (Tuesday)	Morning	<u>Introduction to Fractals</u> <ul style="list-style-type: none"> Making a Koch Snowflake on triangular graph paper placed on poster board Have students construct a Sierpinsky triangle on Poster Board
	Afternoon	<u>Analytical Fractals:</u> <ul style="list-style-type: none"> Finding the area and perimeter of a Koch Snowflake Finding the area and perimeter of a Sierpinsky triangle
	Evening	<u>Menger Sponge. Make Your Own fractal!</u> <ul style="list-style-type: none"> Analysis of Menger Sponge and how fractals apply to non-planar figures Students apply a fractal process to a 3d figure and try to draw it

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9 (Wednesday)	Morning	<u>Introduction to Transformations on a Coordinate Plane</u> <ul style="list-style-type: none"> • Reflections, rotations, transformations, dilations • How each transformation affects coordinates in a Cartesian Plane
	Afternoon	<u>More on Transformations</u> <ul style="list-style-type: none"> • Making a “quilt” with 90 degree rotations • Using translations to create “block letters”
	Evening	<u>Worksheet on Transformations</u> <ul style="list-style-type: none"> • Students complete worksheet as a group • Each group presents a solution
10 (Thursday)	Morning	<u>Introduction to Euler Circuits</u> <ul style="list-style-type: none"> • Definition of a graph • Definition of Euler Path and Euler Circuits, examples • Draw a map of your school with all buildings and paths to buildings: is there an Euler circuit or path?
	Afternoon	<u>Introduction to Hamilton Circuits</u> <ul style="list-style-type: none"> • Definition of a graph • Definition of Euler Path and Euler Circuits, examples • Draw a map of your school with all buildings and paths to buildings: is there an Euler circuit or path?
	Evening	<u>Graph Problems</u> <ul style="list-style-type: none"> • Problems from Tannenbaum
11 (Friday)	Morning	<u>The Golden Ratio</u> <ul style="list-style-type: none"> • Introduction to quadratic equations • Students Solve an Proportion Which Leads to the Golden Ratio • Where does the golden ratio appear in nature? Study of nautilus shell
	Afternoon	<u>Connection Between Fibonacci Numbers and the Golden Ratio</u> <ul style="list-style-type: none"> • Definition of Fibonacci numbers • Explicit formula for the Fibonacci numbers • Application of Fibonacci Numbers, How they lead to the golden ratio

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12 (Sunday)	Evening	<u>Fibonacci and Golden Ratio problems</u> <ul style="list-style-type: none"> • Textbook problems from Tannenbaum
13 (Monday)	Morning	<u>Introduction to Imaginary Numbers and Sequences</u> <ul style="list-style-type: none"> • Assign students locations on complex plane, figure out who is who
	Afternoon	<u>The Mandelbrot Sequence and the Mandelbrot Set</u> <ul style="list-style-type: none"> • Operations of complex numbers to reveal Mandelbrot Set
	Evening	<u>Invent your own Sequence!</u> <ul style="list-style-type: none"> • Create sequence and determine where it converges on the real line • Test 30 points on imaginary plane to get approximate view of fractal that sequence creates
14 (Tuesday)	Morning	<u>Introduction to Cryptology</u> <ul style="list-style-type: none"> • Introduction to simple Cesar and other shift ciphers • Introduction to Affine cipher • Adding in modular arithmetic, connection to cryptology
	Afternoon	<u>General Encryption:</u> <ul style="list-style-type: none"> • Proof that there are an infinite number of primes • Connection between prime numbers and computer encryption • Connection with Riemann's Hypothesis
	Evening	<u>Group work on paradoxes:</u> <ul style="list-style-type: none"> • Establish view of mathematics as a logical system • Introduce the concept of a paradox and the law of the excluded middle • Students work in groups to resolve paradoxes and whether a situation is self contradictory
15 (Wednesday)	Morning	<u>Even and Odd Functions</u> <ul style="list-style-type: none"> • Connections between functions and transformations • How to determine whether a given function is even or odd • Application of even and odd functions

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	Afternoon	<u>Polyominoes Project:</u> <ul style="list-style-type: none"> • Connections between combinatorics and transformations • Principles of counting and how to determine the number of polyominoes for a given area • Relationship between perimeter and shape for a fixed area
	Evening	<u>Post Assessment</u> <ul style="list-style-type: none"> • Administer post assessment • Discuss solutions afterwards
16 (Thursday)	Morning	<u>Topics for final project (Library)</u> <ul style="list-style-type: none"> • Discuss format and expectations of final project • Explore topics for final project • Students begin researching their final topic at the library
	Afternoon	<u>Work on Final Project</u> <ul style="list-style-type: none"> • Students work on their paper and poster board for their final topic
	Evening	<u>Work on Final Project</u> <ul style="list-style-type: none"> • Students work on their paper and poster board for their final topic
17 (Friday)	Morning	<u>Present Final Project</u> <ul style="list-style-type: none"> • Students give a 10 minute presentation on their final project