

## *Mathematical Modeling Syllabus*

Textbook: Excursions in Modern Mathematics. 5<sup>th</sup> Ed. Tannenbaum.

Materials needed: Three ring binder, pen (with no eraser), lined loose-leaf paper, and a scientific calculator will be helpful but not necessary, we have access to graphing calculators if we need them.

Objectives: “Mathematical Excursions” can describe any exploration into mathematics. The explorations can take on any form from looking at general algebras, geometries, and the like to analyzing social issues, patterns in nature, and finding ideal routing paths. We will be looking at the mathematics that is used in various areas of life which include: voting systems, apportionment, graph theory, symmetry, art, growth patterns, and whatever else we find along the way.

Assessment: You will have various forms of work in this class which will include “notes” and scratch work, day-class/in-class work (exercises and explorations), evening-class/out-of-class work (short essay write-ups, deeper-depth exercises, and readings), in-class projects, and out-of-class projects. You will be expected to put every piece of paper that you write on into your three ring binder and separate the papers according to the previous distinctions. This binder will become your portfolio, which we will use to evaluate your work this summer. So it is extremely important that we see every bit of work that you have, from your scratch work to your final written essays. This portfolio will be collected every couple of days during the evening sessions and returned the next day so we can see your progress throughout the summer.

Other notes: It is expected that you will be working in groups for most of your time here. So patience and cooperation are very important qualities to display this summer. You will most likely have different partners every day, so it is your job to help others who are having difficulty and to ask for help from others if you are having difficulty. We are all here to learn about mathematics and no one person has all of the answers to every question, we each have our strengths and weaknesses.

In your groups, you all may collaborate on the explorations, but you must write up your own work completely. This means that all the work in your portfolio must be yours (unless otherwise told by the Instructors), and this also means that you are to write up your exercises, explorations, and essays as completely as you can. Do not feel shy about writing in mathematics and do not erase anything. If you feel that you have written something that you don't want, simply put a line through it (don't scribble it out) and move on with your thoughts. Keeping a running dialogue on your paper is a great idea.

**Course Plan:**

		<b>What (Skill/goals/ knowledge goals/ concepts/ readings)</b>	<b>How (activities)</b>
<b>Day 1</b>	Morning	Introductions, Introduction to voting	Breakfast cereal voting, Plurality vs. Borda Count
	Afternoon	Continue voting, Fairness Criteria, Summation Discussion	Continue cereal voting, Analyze all methods
	Evening	Read 1.1-1.5, Exercises pg 31; 13,19,29,35,55 Essay on voting systems	
<b>Day 2</b>	Morning	Finish discussion on voting, Weighted voting systems, Analyze vote according to Banzhaf and Shapley- Shubik power indices	Form groups according to grades, vote on spokesperson, cast vote on dress codes
	Afternoon	Fair division, Discuss fairness assumptions, Divisions between 2, 3, 4, ..., $n$ people,	Lone divider, lone chooser, last diminisher methods write up Prove lone chooser mathematically, Island posterboard activity, Candy example for method of markers
	Evening	Read 2.3, 2.5, handouts, Exercises: pg 75, 21,25,45ab,63, Work on other unfinished work	Finish in class work from today
<b>Day 3</b>	Morning	Intro to apportionment methods, Spread sheet activities	
	Afternoon	Apportionment cont.	Computer lab for work with excel and analyzing 2000 election with apportionment
	Evening	Apportionment cont.	Computer lab cont. Bush vs. Gore worksheet
<b>Day 4</b>	Morning	Method of sealed bids,	Using wills and getting fair shares
	Afternoon	Method of markers	Division of candy fairly

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	Evening	Work on unfinished work and start on book problems for Sunday night	Ch 2, 3,19,47 Ch 3, 13,17,27,43,51,57 (choose 3) Ch 4, 5,11,21,29,37
<b>Day 5</b>	Morning	Introduction to Euler circuits. Definitions,	Mini-Play “The Case of the Stolen Diamonds”, Worksheet of eight problems for explorations
	Afternoon	Explore theorems and Fleury’s algorithm	Map of Kingsburg, Map of office floorplan
	Evening		
<b>Day 6</b>	Morning	Introduction to Hamilton circuits.	Explore traveling salesperson problems
	Afternoon	Explore algorithms for solving Hamilton circuits	Students explore examples and try to arrive at algorithms
	Evening	Work on problems unfinished and new Hamilton circuit problems	
<b>Day 7</b>	Morning	Introduction to networks. Definitions (trees,...). Kruskal’s Algorithm.	Students explore examples and arrive at algorithms
	Afternoon	Torricelli’s construction. The shortest network rule.	Explore Steiner points and shortest distance between A, B, and C
	Evening	Work on unfinished problems and new network problems	
<b>Day 8</b>	Morning	Introduction to Fibonacci Numbers and the Golden Ratio	Definitions (recursive and global) of fibonacci numbers
	Afternoon	Gnomons and nature	Definitions (similar, gnomon,...). Construction of Spiral growth with poster board. A walk through nature to collect gnomonic items
	Evening	Wok unfinished and new Fibonacci problems	
<b>Day 9</b>	Morning	Continue Fibonacci	
	Afternoon	Explorations of Fibonacci	Patterns around campus and in fruit

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	Evening	Work unfinished and new population growth problems	
<b>Day 10</b>	Morning	Introduction to symmetry.	Definitions (rigid motions) Symmetries of a square and algebra.
	Afternoon	Introduction to frieze patterns,	Begin frieze patterns project (draw on poster board)
	Evening		
<b>Day 11</b>	Morning	Continue frieze project. Discussion of wallpaper patterns.	Examine work of George Polya and M.C. Escher.
	Afternoon	Continue Wallpaper patterns.	
	Evening	Work unfinished and new symmetry problems	
<b>Day 12</b>	Morning	Introduction to fractal geometry	Definitions, Koch Snowflake, Sierpinski Gasket. Construct one of the two previous on cardboard paper.
	Afternoon	Continuation of Fractal geometry	Self-similarity. Self-similarity in nature (broccoli and cauliflower).
	Evening	Work unfinished and new fractal problems. Start on project.	
<b>Day 13</b>	Morning	Continuation of Fractals	Mandelbrot set and self-similarity.
	Afternoon	Work unfinished and project	Computer lab
	Evening	Work on project	Computer lab
<b>Day 14</b>	Morning	Present project	Computer lab
	Afternoon	Present project	Computer lab
	Evening		Computer lab
<b>Day 15</b>	Morning	Set (math card game) Tournament	
	Afternoon		
	Evening		