

## Math 490: Mathematics of Social Choice

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**Office Hours:** Monday: 3-4pm, Thursday 12:30-2:30pm, Friday: 10-11:30am , BoDine 304  
or by appointment  
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### Overview

We'll take a mathematical look at problems that arise in a representative democracy. Topics include social choice procedures, yes-no voting systems, power indices, the Electoral College, apportionment, fair division, and game theory. There are no prerequisites.

The curriculum will be divided into four parts. We'll first explore social choice procedures, contrasting several ways to hold an election between two or more candidates. Next we'll look at yes-no voting systems, analyzing the power wielded by different members of a legislative body. Third, we look at the problem of apportionment, how to distribute representatives proportional to population. Finally, we'll take a tour of fair division problems, or how a set of finite resources can be fairly divided between several competing parties.

This class is on mathematics and politics, not statistics and politics. The latter idea—analyzing polling data, predicting voter behavior, using historical election results to understand future ones—would also be a great course, but it's not this one. Instead we talk about the abstract mathematical problems that arise while creating a democracy in the first place: how we count votes, make legislative decisions, draw congressional districts, settle political conflicts, and generally try to allocate resources in a way that is fair. The main theme we'll discuss is what “fair” really means mathematically, and whether we can ever achieve it. The mathematical skills needed will mostly be related to logical thinking rather than computation. You shouldn't need a calculator.

### Course Learning Objectives

Some of the goals for this course are to be able to:

1. Understand mathematics as a system of logical thought, rather than a collection of rules for manipulating numbers.
2. Explore the challenges that arise in elections with three or more candidates, and the strengths and weaknesses of many voting systems used to decide those elections.
3. Study various methods for passing legislation or resolutions, and the issues that arise when trying to quantify how much power a particular group wields.
4. Apply mathematical rigor to the question of what “fairness” means, and investigate several methods for producing fair outcomes in both political and personal disputes.
5. Learn about a wide variety of topics as needed such as: set theory, combinatorics, linear algebra, probability, graph theory, topology, and number theory.
6. Practice turning vague ideas into concrete proofs, and develop the writing skills to make formal mathematical arguments.

## Class Participation

Especially in a course like this one, whose direction depends so much on the particular interests of the students, class participation is vital. Prompt and regular class attendance is expected.

We will not be using a textbook. Instead, one pair of students each class will be asked to take careful notes on the day's discussion. You will probably want to meet together after class to turn your notes into one clean, readable copy. These notes will be submitted to me before the following class, at which point they will be scanned and posted to the course website. You should expect to do this three or four times during the semester, and it will count towards the "class participation" portion of your final grade.

## Homework

Homework will be due on Friday at the start of class. You can turn it in before that time in the SQRC.

## Mini-paper

About halfway through the semester, students will write a mini-paper on a prompt about voting theory.

## Final Project

Towards the end of the semester, students will break into small (1-2 person) groups and select special topics to explore more deeply. A list of topics will be available, but students are also encouraged to suggest their own. Some of these topics are more mathematical (such as learning about a deep proof to a theorem whose results were discussed in class), while others tend toward the political (discussing a particular conflict through the lens of the course). These projects will culminate in a paper and presentation.

## Grades

Your course grade will be determined based on your percentage of points received with these approximate weights:

Category	Percentage
Homework	55 %
Class participation	10 %
Mini-paper	10 %
Project	25 %
Total:	100%

## Collaboration

Collaboration is an important part of learning mathematics and I strongly encourage you collaborate with your classmates on homework. With that said, there is a difference between working with someone else and copying down what they say or write without understanding it. If you read the entire syllabus and made it this far, send me an email with a joke in it.

**On written homework, you are encouraged to work together, and you may get help from others, but you must write up the answers yourself. If you are part of a group**

**of students that produces an answer to a problem, you cannot then copy that group answer. You must write up the answer individually, in your own words.**

### **Academic Integrity**

Any form of academic dishonesty or misconduct will not be tolerated. Cheating of any form will result in disciplinary actions, such as a zero grade or immediate failure of the course, and will be reported to the Office of the Dean.

### **Festival of Scholars and Artists**

The Festival of Scholars and Artists is a campus-wide celebration of student work. It is an opportunity to discuss research, to exhibit, perform, or appreciate art, and to cross disciplinary boundaries. The Festival will be held on Friday, April 17, 2020. Classes will be canceled on that day, but you are still required to participate in the Festival, either by presenting your work or attending presentations by your fellow students. When the final program for the Festival becomes available, I will recommend attendance of specific presentations, and will explain how attendance will contribute to your course grade.

### **Academic Accommodations**

If you require academic accommodations please contact the Student Support Services Office in Albany Quadrangle (503-76-7192 or [access@lclark.edu](mailto:access@lclark.edu)). Once you complete the intake process and the Accommodations Agreement, you may Request to Send your Accommodations Letter. Student Support Services staff will then notify faculty of the accommodations for which you are eligible.