

## **INQ 241: The Mathematics of Voting**

*The Mathematics of Voting and Elections*, Hodge and Klima

*Gaming the Vote*, Poundstone.

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**office hours** by appointment at [calendly.com/minton/15min](https://calendly.com/minton/15min)

**Course Objectives:** *Continue to learn how to do mathematics!* Mathematics is a problem-solving discipline, and can be applied to a surprising number of highly important issues. The growth of analytics in all areas is a direct result of applying mathematical thinking in new areas. In this course, we apply mathematical thinking to various issues related to voting and elections. What does mathematics have to do with voting? There are many ways to vote on a decision; can mathematics be used to find the best voting method? In the House of Representatives, votes are heavily influenced by the number of representatives each state is assigned; how is this determined? How does this relate to the first Presidential veto in U.S. history? How do states divide themselves into Congressional districts? What are the techniques of gerrymandering to create oddly shaped districts that will vote in a particular way? How much power does a voting coalition actually have? If you add people to your coalition, does that increase the amount of power you have? These are some of the questions to be addressed in *The Mathematics of Voting*. You may be surprised to find out that some of the questions do not have answers!

**Intended Learning Outcomes:** At the end of the course, successful students will be able to

- Apply various voting systems to voter preference lists to determine a winner
- Recognize and state some of the fairness violations of voting systems
- Understand why there have been different methods of apportionment used in the US
- Apply the Banzhaf Power Index to analyze power distribution
- State some of the criteria applied in gerrymandering cases

**Attendance Policy:** Attendance and attention in class is essential! Work hard in class and you will have little need for studying the night before a test. You are responsible for everything done in class, through attendance and sharing class notes with classmates. If you miss a class, e-mail or call me before class is over and explain why. With the first unexplained absence, you and your advisor and the registrar will be warned that another unexplained absence will result in removal from the course. **If you have two unexplained absences, you will be dropped from the course.**

**Equipment:** There is a fair amount of number-crunching in this class. For most classes and all tests, you will need some type of calculator that you can operate effectively.

**Study Problems:** Each day, I will give you a list of problems to study, some from the textbook and some posted in Inquire. Work as many of these problems as you can! The study problems indicate what types of questions you will see on tests.

**Worksheets and Papers:** There will be a worksheet each day in class. You may ask anybody for help on these problems, which are designed to make sure you have a good basic idea of what is covered in class. There will be two small papers to write, one on the Electoral College and one on one of the many debates on voting methods. Instructions will be given on separate handouts. You are not to collaborate with other students or use AI helpers such as ChatGPT. You may ask questions in class or in office hours.

**I expect you to spend at least 12 hours of work each week inside and outside of class.**

**Academic Integrity:** The college policy is fully supported. Tests are closed notes, closed book, no electronic devices other than calculators allowed.

**Tests:** There will be four tests, each on the material covered since the previous test. Anticipated test dates are Friday, February 9; Wednesday, February 28; Wednesday, April 3; Friday, April 19. Make-ups must be arranged before the test, or in the case of illness as soon as possible after the test. The final exam is cumulative. **The exam is Tuesday, April 30, 2:00-5:00.**

**The Writing Center @ Roanoke College**, located on the Lower Level of Fintel Library (Room 15), offers free tutorials focused on writing projects and oral presentations for students working in any field. Writers and presenters at all levels of competence may visit the Writing Center at any point in their process—including brainstorming, drafting, organizing, editing, or polishing presentation skills—to talk with trained peer tutors. The Writing Center is open Sunday through Thursday 4 to 9 PM. Stop in, or schedule an appointment at [www.roanoke.edu/writingcenter](http://www.roanoke.edu/writingcenter). Questions? Email [writingcenter@roanoke.edu](mailto:writingcenter@roanoke.edu) or call 540-375-4949.

**Grading:**

Tests and Exam: 60%

Worksheets: 15%

Papers: 20%

Class participation: 5%

Grades may be curved up based on extenuating circumstances, including improvement as the semester goes on.

A: 93-100	A-: 90-92	
B+: 87-89	B : 83-86	B-: 80-82
C+: 77-79	C: 73-76	C-: 70-72
D+: 67-69	D: 63-67	D-: 60-62
F: 59 and below		

**Subject Tutoring**, located on the lower level of Fintel Library (Room 5), is open 4-9 PM, Sunday-Thursday. Subject Tutors are highly trained, current students who offer free, one-on-one (and small group) tutorials in over 80 courses taught at Roanoke College, including: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, and Social Sciences. Check out all available subjects and schedule 30- or 60-minute appointments at [www.roanoke.edu/tutoring](http://www.roanoke.edu/tutoring). If you have a question, feel free to stop by, or contact us at [subject\\_tutoring@roanoke.edu](mailto:subject_tutoring@roanoke.edu) or 540-375-2590. See you soon!

**Accessible Education Services (AES)** is located in the Goode-Pasfield Center for Learning and Teaching in **Fintel Library**. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at [aes@roanoke.edu](mailto:aes@roanoke.edu) to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

**Student Health & Counseling Services** supports students through in-person health appointments, in-person counseling, 24/7 telehealth (TimelyCare), Therapy Assistance Online, as well as resources related to general wellness, LGBTQ+, sexual assault, substance abuse, and suicide prevention. Unmet health needs can negatively impact your performance in this course. Student Health & Counseling Services can help. Please see <https://www.roanoke.edu/shcs> for more information and to access services.

Date	Topics	Study Problems
W 1/17	Introduction	
F 1/19	Majority rules?	p.10 1.27,29,31,32,33,35,36
M 1/22	Plurality, issues	p.28 2.22,23,26,27,28,33,35 plus
W 1/24	Borda count	worksheet plus
F 1/26	Transitivity, Condorcet	p.53 3.28,29 plus
M 1/29	Figure skating, IIA	
W 1/31	Instant runoff, Dodgson	
F 2/2	Fairness criteria	
M 2/5	Arrow's Theorem	
W 2/7	review	
F 2/9	TEST #1	
M 2/12	Positional voting	
W 2/14	Approval voting, Range voting	
F 2/16	Weighted voting	
M 2/19	Isomorphism	
W 2/21	Banzhaf Power Index	PAPER #1 DUE
F 2/23	Paradox	
M 2/26	review	
W 2/28	TEST #2	
F 3/1	Electoral College	

#### Spring Break 3/4-8

M 3/11	Apportionment	
W 3/13	Hamilton vs Jefferson	
F 3/15	Paradoxes	
M 3/18	Divisor methods	
W 3/20	Huntington-Hill	
F 3/22	District size	
M 3/25	Impossibility	
W 3/27	History	PAPER #2 DUE
F 3/29	Good Friday – no classes	
M 4/1	review	
W 4/3	Test #3	
F 4/5	Convexity	
M 4/8	Gerrymandering	
W 4/10	Contiguity	
F 4/12	Convexity	
M 4/15	Equality, Impossibility	
W 4/17	review	
F 4/19	Test #4	
M 4/22	Census issues	
T 4/23	review	
<b>T 4/30</b>	<b>EXAM 2:00-5:00</b>	