

# GESM 160g - Math and Democracy

University of Southern California, Spring 2025

## Table of contents

[Course and instructor information](#)  
[Course materials and resources](#)  
[Course snapshot](#)  
[Course topics](#)  
[Grading system](#)  
[Practice problems and credits](#)  
[Tips for success](#)  
[Schedule of lectures](#)  
[Policies](#)  
[Statement on Academic Conduct and Support Systems](#)

## Course and instructor information

**Instructor:** Jared Warner

**E-mail:** [hjwarner@usc.edu](mailto:hjwarner@usc.edu)

**Office:** KAP 256 and [Zoom room](#)

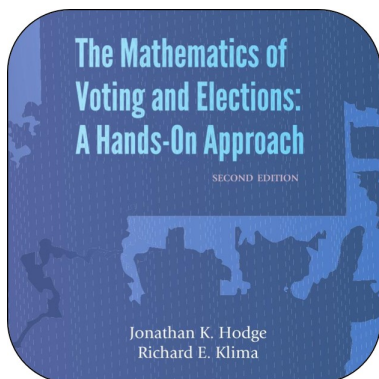
**Office hours:** MWF 9-10am, TTh 8:30-9:30pm

**Lectures:** MWF 12-12:50pm in GFS 113

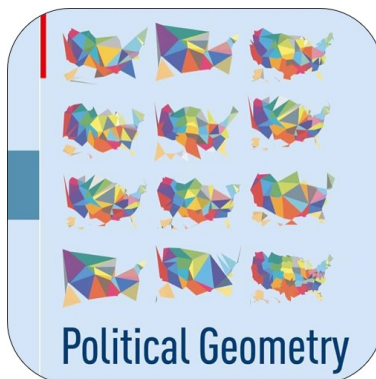
**Course Description:** Voting systems, Arrow's Theorem, power indices, referendum elections, Gerrymandering, fair division.

## Course materials and resources

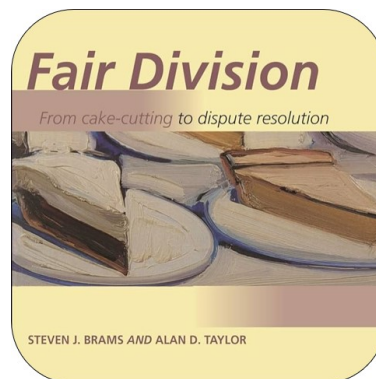
We will use [Gradescope](#) for the submission, grading, and review of assignments. There are no required textbooks for the course, as all content will be self-contained within worksheets found on Brightspace. These worksheets are inspired by the following books.



Hodge, J. K., & Klima, R. E. (2018). *The mathematics of voting and elections: a hands-on approach* (Second edition.). American Mathematical Society.



Duchin, M., & Walch, O. (Eds.). (2022). *Political geometry: rethinking redistricting in the US with math, law, and everything in between*. Birkhäuser.



Brams, S. J., & Taylor, A. D. (1996). *Fair division: from cake-cutting to dispute resolution*. Cambridge University Press.

## Course snapshot

(Read this page for a quick overview of the course structure.)

This is the first topic of the course:

A1 - Two candidate elections and May's Theorem

Throughout the course you will have a score for each topic ranging from 0 to 4 indicating how well you've demonstrated understanding of that topic (everyone starts with 0's in all topics). A score of 4 means you've **mastered** the topic. There are 15 topics in total (listed on the next page), split into Units A, B, and C.

You can improve your topic scores through opportunities and jubilees.

- **Opportunities** are like midterms, and they cover one unit. For example, Opportunity A covers the topics from Unit A. Your topic scores will increase (up to a 4 for each topic) depending on how well you answer the questions on an opportunity.
- **Jubilees** are like re-takes, and they cover all previous topics. For example, Jubilee 2 covers Units A and B. Higher topic scores on jubilees replace lower previous scores, but lower scores on jubilees are discarded. You earn the right to see previous topics on a jubilee by completing practice problems (see the section on ["Practice problems and credits"](#)).

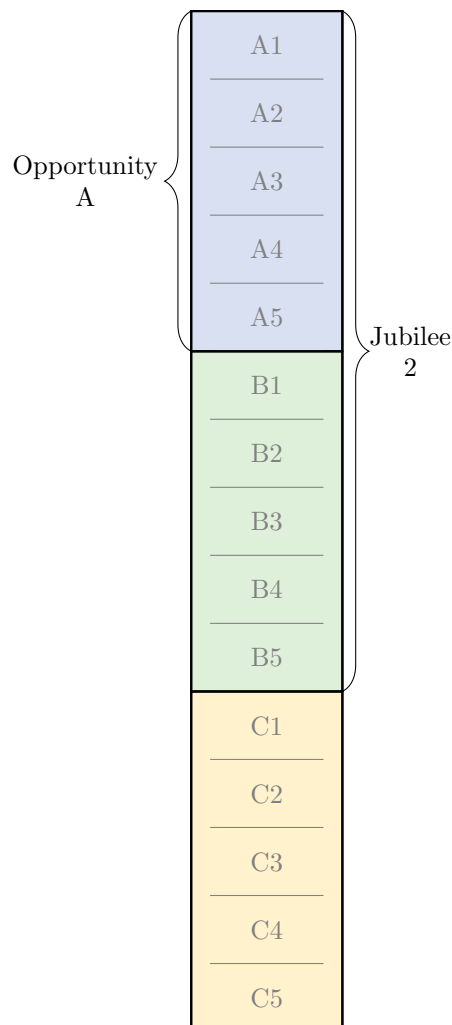
Once you master a topic, you won't see that topic again on any subsequent jubilee, but it may appear again on the final.

Your topic scores are 60% of your grade. The remaining 40% is a combination of your scores on the final and an application. An **application** is a mini-assignment that explores how math is applied to the real-world. These assignments are posted on Brightspace and you can choose to complete at most one, which can be worth up to 10% of your grade. Your grade is then calculated using the following distribution.

Topic scores (from opportunities and jubilees) 60%	Final + Application 40%
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Completing an application is optional, because if you choose not to do them, your final will just be worth more.

That's it! As you read the details in the rest of the syllabus, keep this course snapshot in mind.



## Course topics

The course will focus on the following 15 topics. The topics are split into three units (Units A, B, and C), and each unit will take approximately one month of class time.

Topic
A1 - Two candidate elections and May's Theorem
A2 - Plurality, the Borda count, and preference orders
A3 - Condorcet winners and losers
A4 - Independence of irrelevant alternatives and formalized voting systems
A5 - Arrow's Theorem
B1 - Weighted voting systems
B2 - Banzhaf power index
B3 - Shapley-Shubik power index
B4 - Referendum elections
B5 - Gerrymandering
C1 - Proportional division for two players
C2 - Proportional division of divisible goods for more than two players
C3 - Proportional division of indivisible goods for more than two players
C4 - Envy-free division for two players
C5 - Envy-free division for more than two players

Throughout the semester, you will take various in-class assessments to demonstrate your grasp of these topics. Each topic is graded on a scale from 0 to 4, with a 4 representing mastery of the topic. Each topic can be assessed multiple times so that a low topic score on an early assessment can be replaced with a higher score on a later assessment. Your grade at the end of the semester will be determined partially by your topic scores.

## Grading system

This course will use a mastery-based grading system that is designed to keep our focus on the course topics, emphasize deep understanding of concepts, provide multiple opportunities for students to demonstrate mastery of concepts, and accommodate students with varying mathematical backgrounds.

Below is a description of the various assessments that will determine your grade: opportunities, jubilees, applications, and the final. All in-class assessments are timed and must be completed individually.

**Opportunities (like midterms):** At the end of each unit, you can take an opportunity to demonstrate mastery of that unit's course topics. Opportunities have 5 questions (1 per topic) and each question is scored from 0 to 4.

**Jubilees (like re-takes):** About two weeks after an opportunity, you can take a jubilee to improve your scores on topics you haven't mastered yet. A higher topic score on a jubilee will replace your current topic score. The questions your jubilee contains depend on how many credits you've earned (see the section on ["Practice problems and credits"](#) on the next page).

**Assessment schedule:** The table to the right has all of the dates for in-class assessments. To illustrate how your topic scores change throughout these assessments, suppose your scores for Topic A1 on Opportunity A, Jubilee 1, and Jubilee 2 are 2, 1, and 4. The 2 from Opportunity A is not replaced by the 1 from Jubilee 1, but it is replaced by the 4 from Jubilee 2. You've now mastered A1 and won't see it on any subsequent assessments.

Date	Assessment
2/14	Opportunity A
3/5	Jubilee 1
3/28	Opportunity B
4/11	Jubilee 2
4/25	Opportunity C
5/2	Jubilee 3
5/9	Final

**Applications (like an assignment):** Applications are mini-assignments that explore how the math from our course is applied to the real-world. You can choose to complete at most one application, and if you do, you must discuss your work with me in office hours to receive a grade. This involves setting up an appointment via [Calendly](#). You can sign-up for any of the available slots (through the end of the semester), but you must make your appointment by March 31st, after which the Calendly link will close. Completing an application is optional, and can be worth up to 10% of your grade. See the “Applications” link on Brightspace for more details.

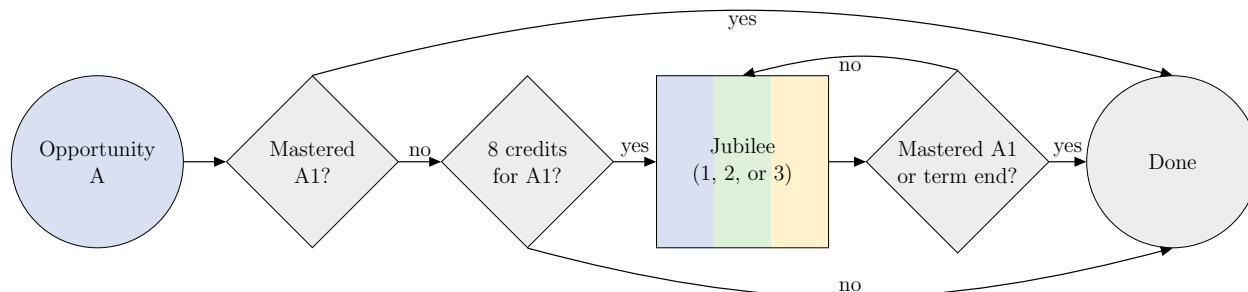
**Final:** The final will be comprehensive and is worth 30-40% of your grade, depending on whether you received a score for an application. The date of the final is Friday, May 9th, 11am-1pm. You must take the final to pass the class.

**Grade:** Your total score (out of 100) will be the sum of your topic scores as achieved on opportunities and jubilees (out of 60) and your applications + final score (out of 40). Your letter grade will then be determined based on your total score relative to the difficulty of the course. I will send regular progress reports throughout the semester which estimate your projected letter grade, but this estimate could be very different from your final letter grade depending on the final distribution. I will do my best to predict as accurately as I can.

## Practice problems and credits

Like most skills, mathematical proficiency is gained through practice. Practice in this course contributes nothing directly to your grade, but allows you to earn **credits** which give you extra chances to improve your topic scores on jubilees. Each topic is paired with 10 **practice problems** on Brightspace. These problems are similar to questions on opportunities and jubilees, and you have unlimited chances to answer each practice problem.

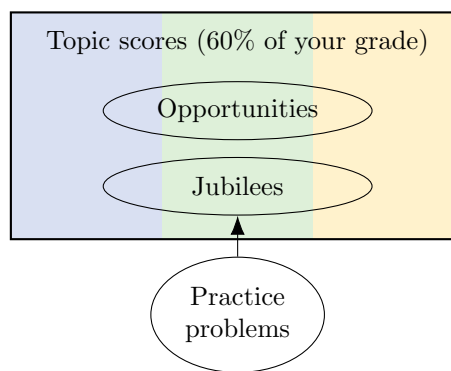
For each topic, your score on the practice problems is the number of credits you have for that topic. If you have earned at least 8 credits for a particular topic you haven't mastered yet, you will have extra chances to improve that topic score on all future jubilees. The flow chart below illustrates this process for Topic A1. Notice once you get 8 credits for a topic, you can try that topic on all future jubilees without needing to earn 8 more credits.



**Due dates:** You can complete practice problems whenever you'd like for full consideration (i.e. there are no due dates and no late penalties). However, there are deadlines you must meet if you want your credits to count towards getting extra chances on your jubilees. Due to the logistical challenge of generating and printing each student's personalized jubilee, these deadlines will not be extended.

- To have your practice problems credited to Jubilee 1 (on 3/5), complete them by 3/2 at 9pm.
- To have your practice problems credited to Jubilee 2 (on 4/11), complete them by 4/8 at 9pm.
- To have your practice problems credited to Jubilee 3 (on 5/2), complete them by 4/29 at 9pm.

The diagram to the right emphasizes that practice problems contribute nothing directly to your grade (notice they are outside of the box), but completing them can give you extra chances to improve your topic scores on jubilees. They can also help prepare you for opportunities, so even though you don't have to do them before the opportunities, I recommended that you do. In this way, you'll score higher on the opportunities so that you won't have to rely on the jubilees as much. You'll also earn your credits ahead of time, so you won't need to worry about the above deadlines.



## Schedule of lectures

Below is a rough schedule for the course. I will post weekly announcements on Brightspace updating you on our progress through the topics for each unit, and any upcoming assessments (i.e. opportunities or jubilees).

Dates	Lecture topic
1/13-2/12	Unit A
2/14	Opportunity A
2/19-3/26	Unit B
3/28	Opportunity B
3/31-4/23	Unit C
4/25	Opportunity C
4/28-5/2	Review and Jubilee 3
5/9	Final

## Tips for success

**Pay attention to your progress reports:** You will regularly receive a progress report to help you keep track of your topic scores, your credits, and what questions you'll see on your next jubilee. Make sure you know how to read this progress report so you can maintain progress toward achieving the grade you want. If you notice a mistake with your progress report, you should reach out to me so I can address it.

**Review your scores on Gradescope:** When you get back a graded assessment on Gradescope, make sure you understand your mistakes to be ready for the next assessment. If you feel your work has been graded inappropriately, submit a regrade request through Gradescope to have the grader consider your work again. If you receive a 3.5 on a problem, you can correct your mistake via email to improve your score to a 4.

**Take lecture seriously:** The lectures are designed with interactive components to help you build the conceptual understanding as a basis for problem-solving. We will also have time to practice problem-solving within lecture. Following along with lecture should set you up for success in the course.

**Do the practice problems before the opportunities:** Even though you don't have to do any practice to see questions on the opportunities, completing the practice problems before opportunities will help you perform better. Furthermore, the practice problem deadlines for jubilees are strict, so doing your practice early keeps you from missing those deadlines.

**Attend discussion and/or office hours for help with practice problems:** The practice problems are challenging, but along with the problems from lecture they represent the best way to prepare for assessments. Working through them alone can be very frustrating. Avoid this frustration by attending discussion and/or office hours to work on these problems with classmates or an instructor.

**Devote the appropriate amount of time outside of class:** According to the USC Curriculum Office's policy on contact hours, for every one hour of in-class contact time per week, students are expected to complete two hours of out of class work per week. Since we have lecture for 2.5 hours each week, this policy suggests you spend 5 hours each week working on this course outside of class. This time can be spent reviewing lecture notes, completing practice problems and/or applications, and studying for in-class assessments. Try forming a study group that meets regularly to work on math.

**Get off to a good start:** Try to do well on early assessments (i.e. don't procrastinate). The grading system is flexible but the course moves fast. If you save too many topics for later, they will accumulate and the last week of the semester will be a lot of work. If you master a lot of topics early on, then you will have fewer to focus on later, so the end of your semester will be easier.

## Policies

**Attendance and participation:** A careful reading of this syllabus reveals that you don't receive any credit toward your grade for attendance or participation. If attending and/or participating in class is helpful for your learning, then you should do it. Otherwise, you should not. Note that for most students (if not all), attendance and participation are helpful and therefore you are encouraged to attend and participate in class.

**Hybrid/asynchronous instruction:** You can choose to attend live class virtually using the "USC Zoom" link on Brightspace. You should keep your microphone muted, but you may unmute yourself to ask questions. Your questions should be heard through the classroom speakers. You can also choose to watch recordings of classes also posted on Brightspace using the "USC Zoom" link, under the "Cloud Recordings" tab.

**Missing an assessment:** To protect academic integrity, all assessments must be taken in-person on the day the assessment is given in class. Due to the challenge of calibrating the difficulty of an assessment, there are no make-up assessments. If you anticipate missing an in-class assessment, you must inform me with at least 24 hours notice (or in the case of an emergency, as soon as possible given the circumstances). I will

then use your performance on the final to act as a stand-in for the missed assessment so that you can still receive an equitable chance to demonstrate the course topics.

**Incomplete grade:** If you miss the final for a documented emergency, you will receive a grade of IN. Consult the Office of Academic Records and Registrar for more information about an IN grade.

## Statement on Academic Conduct and Support Systems

**Academic Integrity:** The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, compromises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

**Students and Disability Accommodations:** USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at [osas.usc.edu](http://osas.usc.edu). You may contact OSAS at (213) 740-0776 or via email at [osasfrontdesk@usc.edu](mailto:osasfrontdesk@usc.edu).

### Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United

States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086 Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298 Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776 OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411 Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101 Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC) A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or [otfp@med.usc.edu](mailto:otfp@med.usc.edu) Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.