MAT 150: Mathematics and Politics (Spring 2024)

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Office Hours : M 1:00 – 3:00, WF 9:00 – 10:30,
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COURSE ANNOUNCEMENT

CLASSES: MWF 10:40 – 11:35, at SH 1013B.

TEXTBOOK: P. Tannenbaum, *Excursions in Modern Mathematics, 10th Ed.*,

with some extra supplements. Chapters 1 – 4 of the textbook will be covered. We will be working with its electronic version, through MyLab Math. See below.

MyLab Math: Everyone is required to register for MyLab Math (www.pearson.com/mylab). In addition to being an e-textbook, HW will be done through this system. Access information will be given separately.

HOMEWORK: As noted above, HW will be primarily done through MyLab, online. A few problems will be assigned online after each class. It is all right if you do this a few days later, but don't delay too much and pile things up. Also occasionally, there will be some short writing problems, separately from those in MyLab.

PARTICIPATION: Students are expected to attend classes and engage themselves. Of course, it will matter to your overall grade. When you are in class, please be courteous to others (e.g. turn off your cell phones).

An assignment will be given almost every class (through MyLab Math). You are expected to do all of these assignments. Future exam problems will be modeled on these problems. There may be some reading assignments from time to time, which you are expected to complete these before the beginning of the next class.

EXAMS: We plan to have three midterm exams, and a comprehensive final exam. The tentative dates for the midterm exams are: Feb 23 (Fri), Mar 18 (Mon), Apr 26 (Fri), though they may change. The date for the final exam will be chosen by the University.

GRADING: Total (700) = HW (150) + Exams (3×100) + Participation (100) + Final exam (150)

DIFFICULTIES: If you have any personal difficulties (illness or any emergency), please let me know so that we can make appropriate arrangements. In addition, in accordance with the University policy, if you have a documented disability and require accommodations to obtain equal access in this course, or any special health or personal circumstances, please contact a relevant university official at the beginning of the semester or when given an assignment for which an accommodation is required. You may also contact the Griff Center (OM 013), at 888-2170.

OVERVIEW: This course is designed for the students majoring social sciences and liberal arts, though any students would learn some new and interesting applications of mathematics to problems of the social sciences. We discuss how mathematics can contribute to important questions about fairness in a variety of situations dealing with decision making, such as determining the winner of an election, forming coalitions in government, dividing inheritances, or apportioning representatives. This course has been approved as fulfilling the **Justice Attribute**.

TOPICS: There are four main topics ...

- **Voting theory**: We will discuss the problems and paradoxes of democratic voting. We will study different ways of tallying the votes and determining the winner of an election, including plurality voting, Borda count, the instant run-off method, and Copeland's method. We will consider **fairness criteria**, such as the Condorcet criterion, the majority criterion, the monotonicity criterion, and independence of irrelevant alternatives and discuss *Arrow's Impossibility Theorem*, which proves that there is no democratic voting procedure that satisfies all of the fairness criteria. We will discuss the problem of insincere votes and manipulative voting.
- **Weighted voting systems**: There are situations in which weighted voting is used, such as shareholder elections (where each shareholder gets as many votes as he or she has shares) and some city councils (where the weights are determined by the number of citizens in each district). We will discuss the distribution of power such a weighted system gives. We will study two theories of measuring power, the Banzhaf power index and the Shapley–Shubik power index. We will discuss the role of dictators, veto power, and coalitions in government. Examples include the Electoral College (in which many states require their delegates vote as a block) and the Security Council of the United Nations.
- **Fair division**: There are many situations where some properties or obligations must be divided among several persons or entities. For example, an inheritance consisting of items of various values might be split between heirs, or mineral rights divided among bidding companies, or chores divided among roommates. In the cases where there is not a predetermined valuation of the things to be divided, we ask how this might be done fairly and in a way that respects the value systems of each individual. We discuss several methods: the divider-chooser method and its extensions (the lone divider, the lone chooser, and the last diminisher), the method of sealed bids, and the method of markers, discussing which method is best suited for different situations.
- **Apportionment**: We will discuss apportionment problems, in which representatives are distributed in proportion to population. We will discuss various apportionment methods that have been used to determining the makeup of the United States House of Representatives: Adams' method, Hamilton's method, Webster's method, Jefferson's method, and the Huntington–Hill method currently being used. We will study the faults of each of these, such as the Alabama paradox, the new states paradox, the population paradox, and finally discuss the *Balinsky–Young Impossibility Theorem*, which proves that there is no absolutely fair way of apportioning representatives.

FIELD 7 GOALS and OBJECTIVES:

Math 106 is one of the Field 7 courses. Here are the goals and objectives for **Field 7** (approved by the Core curriculum Committee) ...

Field 7 courses are ... designated courses that enable students to reason quantitatively, abstractly, or computationally about the world using the symbol systems rooted in quantitative measures, logical analysis, and/or algorithms to solve practical problems.

• **Content:**

[Goal]: Students will be conversant with the essential terminology and concepts of a mathematical, statistical or algorithmic system.

[Objectives]: Students will:

- Demonstrate knowledge of the vocabulary and notation of a mathematical, statistical or algorithmic system.

- Demonstrate understanding of the theory behind the concepts and techniques of a mathematical, statistical, or algorithmic system.

• **Skills:**

[Goal]: Students will have the appropriate skills and techniques used in problem analysis and solution.

[Objectives]: Students will:

- Analyze and apply appropriate quantitative, theoretical, and/or computational techniques to solve problems.

- Interpret the results of their analysis clearly.

JUSTICE ATTRIBUTE GOALS and OBJECTIVES:

This class meets the learning goals for the **Justice Attribute** of the Core curriculum ...

[Goal]: Students will demonstrate an understanding of justice, its relationship to power, and the ways in which causes of injustice may be mitigated and justice promoted.

[Objectives]: Students will:

- Compare and contrast differing theories of justice, including the ways in which justice has been defined and conceived.

- Describe the factors that are responsible for injustice with particular emphasis upon the relationship of injustice to inequities in the distribution of power.

- Describe the ways in which the factors responsible for injustice might be mitigated in the cause of justice.

[Goal]: Students will think critically about the factors that create, permit, and/or mitigate the conditions of justice or injustice.

[Objectives]: Students will:

- Identify how the distribution of power is embedded in institutions, social structures, and/or codes of conduct.

- Critically analyze theories, policies, and practices in so far as they promote either justice or injustice.

- Demonstrate how the conditions of injustice might be mitigated by specific forms of action.

ADDITIONAL INFORMATION:

• Last day to drop/add is 1/22.

• **Academic Intergrity**: Academic integrity is the foundation of intellectual inquiry and growth. Demonstrating respect for intellectual work, whether one's own or others', fosters an atmosphere of trust and facilitates the free exchange of ideas, which is essential for learning. All members of the Canisius University community agree to exercise complete honesty in their academic work and accept responsibility for maintaining academic integrity.

Please note that Canisius University has a Code of Academic Integrity, which can be found at

`https://catalog.canisius.edu/undergraduate/academics/academic-policies/code-academic-integrity/`

It is expected that the work submitted is the result of your own endeavors. It is very much all right to ask for help in understanding the course material, but you should write up your homework on your own, using your own words.

• If you have any questions, you are very much welcome to my office (SH 1047).