Unit One – Voting: Descriptions of Objectives

- **Voting Methods** – Given information about votes, determine the totals and winner under any of the four methods (Plurality, Instant Runoff, Head-to-Head, Borda)
- **Strategic Voting** – Given an unweighted voting method, give an example in which one player could vote strategically to change the outcome to one that they prefer
- **Fairness Criteria 1** – Given an unweighted voting method example and one of the four fairness criteria (Majority, Condorcet, Monotonicity, IIA), show that the system violates or fails to violate the fairness criteria
- **Fairness Criteria 2** – Given an unweighted voting method, explain why the system satisfies one of the four fairness criteria and/or apply Arrow's Impossibility Theorem
- **Weighted Voting** – Given a weighted voting system, find all winning coalitions and critical players to determine the Banzhaf power of each player, and identify any players that are dummies or have veto power
- **Counting Problems** – Set up a mathematical problem involving counting techniques of consecutive sums, factorials, combinations, and permutations
- **Political Context** – Provide examples and discuss implications of voting systems in politics, including in the United States and around the world

Unit Two – Apportionment: Descriptions of Objectives

- **Fractional Methods** – Perform steps of apportionment methods which do not involve modified quotas (Hamilton's, Lowndes') to determine a final allocation of representatives
- **Quota Methods** – Perform steps of apportionment methods with modified quotas (Jefferson's, Adams's, Webster's, Huntington-Hill) to determine a final allocation of representatives
- **Identifying Methods** – Given a partially completed apportionment table or method of rounding, determine which apportionment method(s) could have been used
- **Paradoxes and Violations** – Understand and interpret the types of paradoxes (Alabama, Population, New-states) and their relationship via Balinski and Young's Impossibility Theorem
- **Voting Power** – Calculate and interpret voting power for an individual
- **Political Context** – Understand the setup of the Electoral College and its relationship between voting and apportionment, the history of apportionment methods in the United States, and the use of apportionment methods around the world

Unit Three – Redistricting: Descriptions of Objectives

- **Grid Analysis** – Given a grid and a distribution of voters, determine how many districts (mathematically) it is possible for each party to win and divide the grid into districts to achieve various outcomes
- **Redistricting Concepts** – Demonstrate an understanding of key terms including redistricting vs. gerrymandering, partisan vs. racial gerrymandering, packing and cracking, proportional representation, and competitive elections
- **Efficiency Gap** – Calculate and interpret the efficiency gap through the number of "wasted votes" for each party and how that translates to an advantage in representation
- **Compactness** – Calculate the compactness scores using three different tests (Polsby-Popper, Convex Hull, Population) and interpret their meaning through the compactness criteria
- **Political Context** – Understand the role of redistricting in the United States' political system, including your local representatives, the redistricting process for a particular state, and a newly created redistricting plan

Unit Four – Game Theory: Descriptions of Objectives

- **Game Matrices** – Set up and solve a simultaneous game matrix and determine any pure strategy Nash Equilibrium points, maximin strategies, and any Pareto optimal solutions
- **Iterated Elimination** – Apply this strategy to a game matrix to solve for a Nash equilibrium or to reduce the size of a game matrix
- **Sequential Games** – Set up and solve a sequential game tree using the strategy of backwards induction and interpret the results
- **Mixed Strategies** – Calculate expected values in general and mixed strategy probabilities for both players in a simultaneous game with no pure strategy Nash equilibrium points
- **Repeated Games** – Understand and apply the strategies and roles of communication and trust when playing simultaneous games repeatedly against the same opponent

Overall Course Objectives

- **US Elections** – Research and discuss results of the 2020 US Elections, including Presidential, Senate, House, State, and particular ballot initiatives
- **Engagement** – Regularly attend and participate in the course, and complete a reflection paper at the beginning and the end of the course