

The actual test is about **half as long** as this sample test.

Directions: failure to follow directions may be **harmful** to your grade :-)

- No graphing and/or programmable calculators, or other electronic devices are allowed.
- No lending/borrowing of calculators is allowed.
- Write your
 - Name,
 - B-number
 - section number, andon top of the first page.
- Read **all** problems first. Try working on them from easiest to hardest.
- In order to get any credit you must **show all your work** on the exam pages.
- This test is worth only 15% of your final grade, so do not panic.

1. For each statement below, indicate whether it is true (**T**) or false(**F**).
 - (a) The system $[18 : 10, 5, 2, 1]$ is non-functional.
 - (b) In the UN Security Council, every member has veto power.
 - (c) John Quincy Adams invented Adams' method.
 - (d) The *pairwise comparisons method* satisfies the *Condorcet criterion*.
 - (e) A *continuous* fair division problem is one where the items to be divided cannot be cut into pieces without losing some of their value.
2. Circle the correct choice
 - (a) Which apportionment method was adopted for the US House of Representatives in 1791.
 - i. Hamilton method,
 - ii. Jefferson method,
 - iii. Adams method,
 - iv. Webster method.
 - (b) Who proved, in 1952, that there can be no voting system satisfying all four fairness criteria.
 - i. John Banzhaf,
 - ii. Kenneth Arrow,
 - iii. Edward Huntington,
 - iv. Jean-Charles de Borda.
3.
 - (a) What are the two characteristics under which we classify voting systems?
 - (b) List the four types of voting systems we studied in class.
4. In regard to the "One person – One Vote; Multiple Candidates" type of voting system
 - (a) name the four voting methods discussed in class;
 - (b) name the four fairness criteria discussed in class;
 - (c) describe each one of the four methods listed in (4a) in full detail;
 - (d) describe each one of the four criteria listed in (4b) in full detail.
 - (e) Which of the voting methods listed in (4a) satisfy all four fairness criteria? Explain.

5. (a) Compile the preference schedule for the following preference ballots from an election with five candidates, and 24 ballots.

Ballot 1st. C 2nd. A 3rd. E 4th. B 5th. D	Ballot 1st. A 2nd. B 3rd. C 4th. D 5th. E	Ballot 1st. C 2nd. A 3rd. E 4th. B 5th. D	Ballot 1st. E 2nd. D 3rd. A 4th. C 5th. B	Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. B 2nd. D 3rd. C 4th. E 5th. A	Ballot 1st. A 2nd. B 3rd. C 4th. D 5th. E	Ballot 1st. C 2nd. A 3rd. E 4th. B 5th. D
Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. E 2nd. D 3rd. A 4th. C 5th. B	Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. C 2nd. A 3rd. E 4th. B 5th. D	Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. C 2nd. A 3rd. E 4th. B 5th. D	Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A
Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. A 2nd. B 3rd. C 4th. D 5th. E	Ballot 1st. B 2nd. D 3rd. C 4th. E 5th. A	Ballot 1st. B 2nd. D 3rd. C 4th. E 5th. A	Ballot 1st. B 2nd. E 3rd. C 4th. D 5th. A	Ballot 1st. B 2nd. D 3rd. C 4th. E 5th. A	Ballot 1st. A 2nd. B 3rd. C 4th. D 5th. E	Ballot 1st. A 2nd. B 3rd. C 4th. D 5th. E

- (b) Find the winner of the election using the **pairwise comparisons** method.
6. The preference schedule for an election with 4 candidates and 20 voters is given in the table below.

Choice	Number of ballots			
	8	5	4	3
1st	A	B	C	D
2nd	B	A	B	B
3rd	C	C	A	A
4th	D	D	D	C

- (a) Find the winner of the election using the **plurality** method.
- (b) Find the winner of the election using the **plurality with elimination** method.
7. The Latin Club at Clearview State College is holding an election for its officers: President, Secretary, and Treasurer. There are four candidates A, B, C, and D. Each of the 50 members of the club will cast a preference ballot, and the **Borda count method** will be used to **rank** the four candidates. The first place candidate will become President; the second place candidate will become Secretary; and the third place candidate will become Treasurer. Determine the elected officers, given the preference schedule below:

Choice	Number of ballots				
	17	14	13	4	2
1st	A	D	D	C	A
2nd	B	B	B	A	D
3rd	C	A	C	B	B
4th	D	C	A	D	C

8. Consider the weighted voting system given by $[q : 10, 5, 2, 1]$.
- How many voters are there? How many coalitions are there?
 - What are the possible values of q ?
 - For which values of q is there a dictator? Who will that be?
 - For which values of q are there voters with veto power? Who will that be?
9. Consider the weighted voting system given by $[12 : 10, 5, 2, 1]$.
- List all the winning coalitions with their weight.
 - Underline the *critical voters* in each winning coalition.
 - Are there any *dummy voters*? Explain.
 - Find the power distribution of this voting system.
10. (a) What is an **unsolvable tie** in a voting system?
- (b) How are individual comparison ties resolved in the Pairwise Comparisons method?
11. (a) What are the three characteristics under which fair division problems are classified?
- (b) List the eight types of fair division problems that arise from the classification in (11a).
- (c) Which type of fair division problem is the “*apportionment problem*”?
12. The Eusklavia Confederation consists of five autonomous republics, A, B, C, D, and E, and has a legislature with 50 seats. The legislature seats are apportioned according to the republics’ population. The population of the republics, in millions, is given in the following table:

Republic	A	B	C	D	E
Population	5.65	4.35	8.35	3.98	6.51

Find the apportionment of seats using Adams’ method.