1. For the first 5 questions, consider the following profile (the orderings go from the most preferred at the top to least preferred).

Number of voters	4	1	9	8	5
	A	B	C	A	D
	C	A	D	B	C
	B	D	A	D	B
	D	C	B	C	A

(a) The Borda winner is

   ○ A   ○ B   ○ C   ○ D

(b) The Plurality winner is

   ○ A   ○ B   ○ C   ○ D

(c) The winner according to the Hare rule (also known as Ranked-Choice Voting) is

   ○ A   ○ B   ○ C   ○ D

(d) The winner according to the Coombs rule is

   ○ A   ○ B   ○ C   ○ D

(e) The winner according to Plurality with Runoff is

   ○ A   ○ B   ○ C   ○ D

(f) Recall that the majority ordering ranks A above B provided a majority of voters prefer A over B. An ordering P has a cycle provided there is a sequence $X_1, \ldots, X_n$ such that $X_1 P X_2 P X_3 \cdots X_n P X_1$. We say that P is acyclic when there are no cycles. Select all statements that are true.

   ○ The majority ordering is always acyclic.

   ○ If the majority ordering is acyclic, then there is a Condorcet winner.

   ○ If there is a Condorcet winner, then the majority ordering is acyclic.

   ○ There always exists a Condorcet winner.

(g) Which of Arrow's axioms does the Borda ranking satisfy (i.e., order the candidates according to their Borda score).

   ○ Universal Domain

   ○ Independence of Irrelevant Alternatives

   ○ Unanimity

   ○ Group Rationality (i.e., the Borda ranking is complete and transitive)

(h) In following question, assume that voters select their candidates sincerely (i.e., if the voter approves of candidate B, then the voters approves of all candidates ranked strictly above B). Select all the statements that are true.

○ Approval vote may not elect a Condorcet winner (even if one exists)

○ Approval vote may elect a candidate that is ranked strictly lower than another candidate by all voters.

○ Approval vote may not elect the Condorcet winner.

○ Approval vote may not elect a plurality winner.

○ Approval vote may not elect a majority winner.

(i) Consider the following game:

Bob

		l	r
Ann	u	2, 3	0, 4
	d	1, 0	10, 10

Select all the outcomes that are pure strategy Nash equilibria.

○ (u, l)

○ (u, r)

○ (d, l)

○ (d, r)

2. Consider the following lotteries:
$L_1 = [.5 : 0, .25 : 20, .25 : 50]$
$L_2 = [.25 : 0, .25 : 10, .25 : 20, .25 : 40]$
$L_3 = [.5 : 0, .25 : 100, .25 : L1]$

(a) Which option would a rational decision-maker choose (**expected utility maximization**)?

○ L_1

○ L_2

○ L_3

○ Either of L_1 or L_3 (i.e., they are tied)

○ Any of the three options (i.e., all are tied)

(b) Suppose we used the **lexicographic minimax decision rule** instead of EU maximization. Which option would *this* decision-maker choose?

○ L_1

○ L_2

○ L_3

○ Either of L_1 or L_3 (i.e., they are tied)

○ Any of the three options (i.e., all are tied)

3. We discussed a number of theorems and paradoxes this semester. State each of the following theorems or paradoxes *and* explain in your own words what are the implications of the theorem for group/individual decision-making:
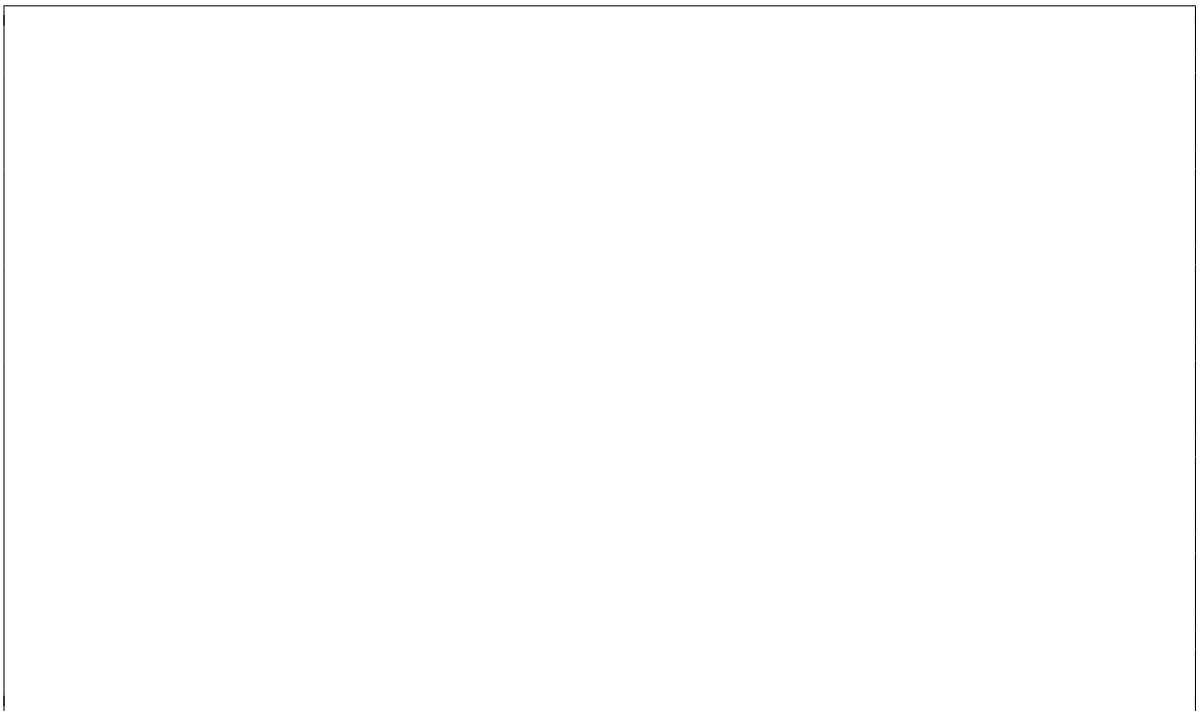
Money Pump Argument

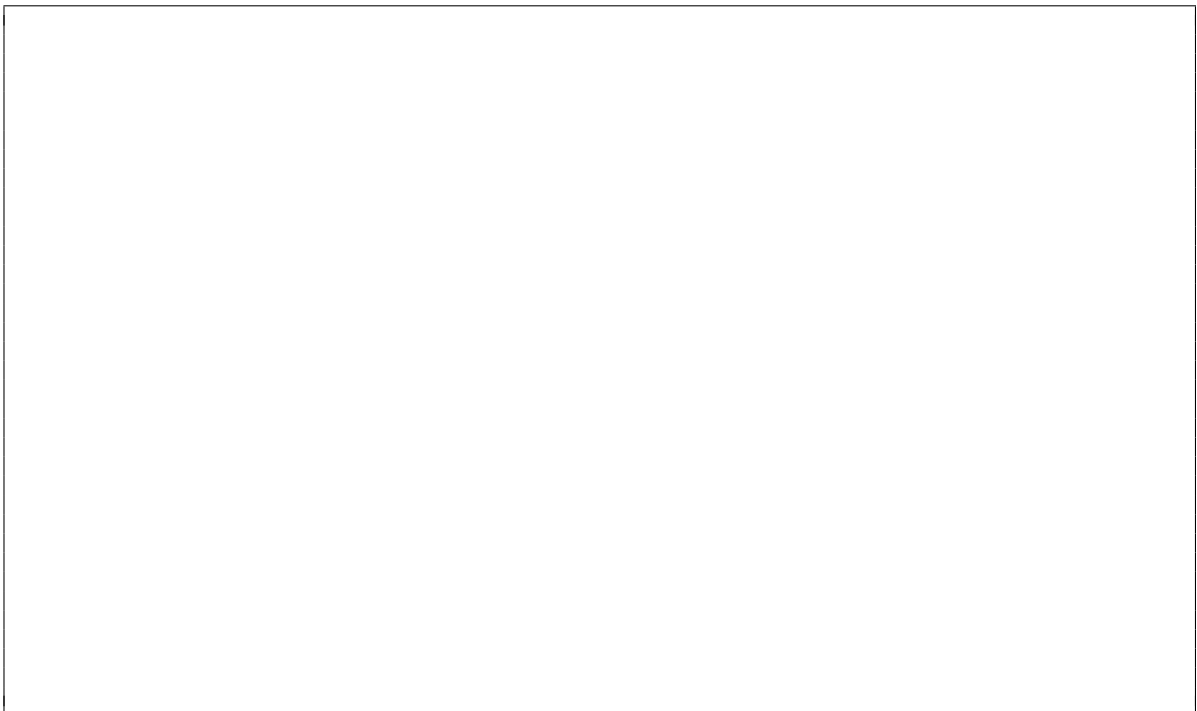von Neumann-Morgenstern Theorem

Newcomb's Paradox

Allais Paradox

Ellsberg Paradox

Condorcet Paradox

May's Theorem

Arrow's Theorem

Condorcet Jury Theorem

Judgement Aggregation Paradox (The Discursive Dilemma/Doctrinal Paradox)

4. What is the Prisoner's Dilemma? What are the Nash equilibria? Why do game theorists and philosophers find this game puzzling?

5. Throughout the course, we assumed that the decision maker's preferences are complete and transitive. Give an argument in favor of this assumption. (I.e., give an argument in favor of assuming that a decision maker's preference ordering is transitive and an argument in favor of assuming that a decision maker's preference ordering is complete). What are the arguments against making these assumptions?

6. What is a Nash equilibrium? Is it always rational to play a Nash equilibrium? You must explain your answer (using examples).

7. What are the principles of invariance and stability when developing mathematical models of individual decision making? What is the dilemma that Economists face when developing mathematical models of rational decision making? (Hint: Consult the Reiss chapter on rational choice).

8. What is the problem of interpersonal comparison of utilities? Give an example that illustrates some of the issues that arise when aggregating decision maker's utilities.