PAPER CODE NO.	EXAMINER : Michael Wooldridge
COMP310	DEPARTMENT : Computer Science Tel. No. 07540 845 345

UNIVERSITY OF
LIVERPOOL

Second Semester Examinations 2011/12

Multiagent Systems

TIME ALLOWED : Two and a Half hours

INSTRUCTIONS TO CANDIDATES

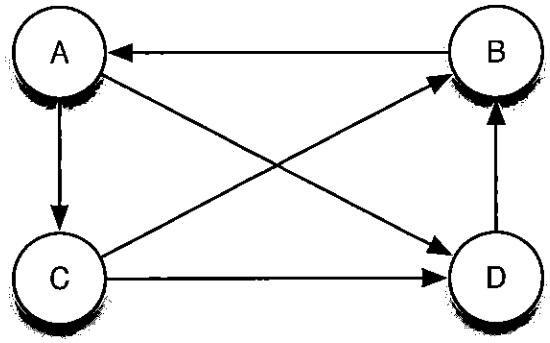
Answer **four** questions.

If you attempt to answer more questions than the required number of questions (in any section), the marks awarded for the excess questions answered will be discarded (starting with your lowest mark).

UNIVERSITY OF LIVERPOOL

Question 1

The following figure shows a majority graph for a social choice scenario.



a) For each of the four candidates, state whether they have any chance of winning in a sequential majority election. Where the answer is "yes", give an example of a linear agenda that would lead to the respective candidate winning.

[10 marks]

b) The *Gibbard-Satterthwaite theorem* seems to be a very negative result in social choice theory. Explain what you understand by the Gibbard-Satterthwaite theorem and its implications, and explain the implications of computational complexity with respect to this result.

[10 marks]

c) *Arrow's theorem* is a fundamental impossibility result in social choice theory. Explain what you understand by Arrow's theorem, and its implications.

[5 marks]

Question 2

a) In the context of cooperative games, consider the following marginal contribution net:

$$\begin{aligned} a \wedge b &\longrightarrow 5 \\ b &\longrightarrow 3 \\ c &\longrightarrow 2 \\ b \wedge c &\longrightarrow 1 \end{aligned}$$

Let ν be the characteristic function defined by these rules. Give the values of the following:

i) $\nu(\{b\})$

ii) $\nu(\{a, b\})$

iii) $\nu(\{b, c\})$

iv) $\nu(\{a, c\})$

v) $\nu(\{a, b, c\})$

[15 marks]

b) Define and explain the *Shapley value*, with special reference to the properties the Shapley value satisfies.

[6 marks]

c) With the aid of explanation, give the Shapley values for the players a, b, and c in the cooperative game defined above.

[4 marks]

Question 3

The Prisoner's Dilemma is often interpreted as being "proof" that rational cooperation between self interested agents is impossible in many important settings. However, natural variants of the Prisoner's Dilemma exist in which rational cooperation is possible.

a) If two players play the *Iterated Prisoner's Dilemma* an infinite number of times, rationally sustained cooperation is possible. Explain how, assuming that players enter strategies as finite automata.

[10 marks]

b) Is rationally sustained cooperation possible when two players play the Iterated Prisoner's Dilemma a fixed, finite, pre-determined, commonly known number of rounds? Justify your answer.

[5 marks]

c) Another solution to the Prisoner's Dilemma is to consider *program equilibria*, in which players submit strategies that may be conditioned on the programs submitted by others. The following is an example of such a program:

```
IF OtherProgram == ThisProgram THEN
  DO(COOPERATE);
ELSE
  DO(DEFECT);
END-IF.
```

With reference to this program, explain how the framework of program equilibria permits cooperation as a rational outcome in the prisoner's dilemma.

[10 marks]

Question 4

This question considers automated negotiation.

a) With the aid of examples, define what is meant by a *task-oriented negotiation domain*.

[5 marks]

b) In negotiation scenarios, the *negotiation set* is the set of deals that players are allowed to propose. Define the properties of deals in the negotiation set.

[5 marks]

c) Define the *monotonic concession protocol* for negotiation.

[5 marks]

d) The Zeuthen strategy for negotiation answers two questions that must be answered on any given round of negotiation: *who should concede?* and *how much should they concede?* Explain the answers that the Zeuthen strategy provides to these questions.

[10 marks]

UNIVERSITY OF LIVERPOOL

Question 5

The following payoff matrix is for "game of chicken".

		i defect	*i* coop
j	defect	1 1	2 4
	coop	4 2	3 3

a) Explain the notion of *maximising social welfare*, being sure to explain the limitations with naively trying to maximise (utilitarian) social welfare. Identify with justification the outcome(s) in the above payoff matrix that maximise social welfare.

[5 marks]

b) Explain and define the notion of a *Pareto efficient* outcome. Identify with justification the Pareto efficient outcome(s) in the above payoff matrix.

[5 marks]

c) Explain and define the solution concept of *pure strategy Nash equilibrium*. Identify with justification the pure strategy Nash equilibrium outcome(s) in the above payoff matrix.

[10 marks]

d) The following payoff matrix is for the game of matching pennies:

		i heads	*i* tails
j	heads	1 -1	-1 1
	tails	-1 1	1 -1

With reference to this payoff matrix, explain the notion of *mixed strategy Nash equilibrium* and Nash's Theorem.

[5 marks]