INSTRUCTIONS:

Answer all questions. The marks for the paper total 100.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found.

Therefore, any candidate who has brought any unauthorised material whatsoever into the examination room should declare it to the supervisor immediately. Candidates who are uncertain whether any material is authorised should ask the supervisor for clarification.
Q1. Search algorithms

(a) Define the terms completeness and optimality as they apply to search algorithms in AI. 2 marks

(b) Briefly describe breadth-first and depth-first search. 2 marks

(c) Why is the space complexity of depth-first search much better than breadth-first? 2 marks

(d) Briefly describe iterative deepening search, and describe how it attempts to get the best performance features of both breadth-first and depth-first. 4 marks

Q2. Informed search algorithms

(a) What is the fundamental difference between an informed search algorithm and an uninformed one? 2 marks

(b) What does it mean for a heuristic to be admissible? Describe briefly why this is important in the performance of A*. 3 marks

(c) Given two admissible heuristics $h_1$ and $h_2$, what does it mean if $h_1$ dominates $h_2$? In what way will A* using $h_1$ out-perform A* using $h_2$? 3 marks

(d) What problem does simplified memory-bounded A* attempt to solve? 2 marks

Q3. Game-playing algorithms

(a) What is meant by look-ahead in the context of game-playing algorithms? 1 mark

(b) What is an evaluation function in the context of game-playing algorithms? What degree of look-ahead do evaluation functions typically use? 2 marks

(c) Describe briefly what is meant by the horizon problem in algorithms that use look-ahead. 2 marks

(d) Describe briefly what is meant by the quiescence problem in algorithms that use look-ahead. 2 marks

(e) Describe briefly how α-β pruning improves the performance of algorithms that use look-ahead. 3 marks
Q4. Learning agents

(a) Describe briefly the four basic components of a learning AI agent, and their roles.  
4 marks

(b) Describe briefly the two principal goals of the learning element in such an agent.  
1 mark

(c) What is a decision tree in the context of learning agents?  
Describe briefly how an agent might induce a decision tree from a set of data.  
3 marks

(d) Describe briefly two plausible rules that such an agent could use to order the attributes of the data when inducing a decision tree.  
2 marks

Q5. Sequential decision problems

(a) Describe briefly what is meant by a sequential decision problem (SDP).  
2 marks

(b) What two features of SDPs usually render traditional search algorithms ineffective?  
2 marks

(c) What is meant by discounting in the context of SDPs?  
For what kind of problems is discounting especially important?  
3 marks

(d) Describe briefly the value iteration algorithm for solving SDPs.  
3 marks

Q6. Reinforcement learning

(a) What is the principal difference between passive learning and active learning?  
2 marks

(b) What is the principal operational difference between adaptive dynamic programming and temporal difference learning?  
2 marks

(c) What is meant by exploration and exploitation in the context of learning?  
What roles do they normally play for a learning agent?  
4 marks

(d) What are the two principal advantages of using an implicit representation for a decision mechanism vs. an explicit representation?  
2 marks
Q7. Planning

(a) What are the three principal differences between a searching algorithm and a planning algorithm? 3 marks

(b) Describe briefly how a partial-order planner works. What is its principal operational advantage? 3 marks

(c) What does it mean if a new action added to a plan clobbers an existing action? What are the two usual ways that clobbering is avoided? 4 marks

Q8. Logical agents

(a) What are the two components of the decision-making apparatus of a logical AI agent? Why is it important to keep the two components separate as far as possible? 4 marks

(b) Define the terms sound and complete in the context of an inference system. Which is generally regarded as more important, and why? 3 marks

(c) Describe briefly the forward chaining and backward chaining proof methodologies. Why does backward chaining often out-perform forward chaining? 3 marks

Q9. First-order logic

(a) Describe briefly the principal limitation of propositional logic vs. first-order logic (FOL). Give an example (in English) of a statement that can be captured in FOL but that is difficult to say in propositional logic. 4 marks

(b) Define quantifier duality in FOL. 2 marks

(c) Describe briefly the two restrictions that apply to existential instantiation in FOL, that do not apply to universal instantiation. 2 marks

(d) Describe briefly the frame problem in the context of knowledge representation. 2 marks
Q10. Knowledge engineering

(a) What is the fundamental dichotomy in the use of logics in AI? 4 marks

(b) How is that dichotomy resolved in the specific case of temporal logics? 3 marks

(c) How is that dichotomy resolved in the specific case of description logics? 3 marks

END OF PAPER