EASTERN UNIVERSITY, SRI LANKA
DEPARTMENT OF MATHEMATICS
THIRD EXAMINATION IN SCIENCE – 2015/2016
FIRST SEMESTER (May/June, 2018)
CS 304- Artificial Intelligence

Answer all questions **Time: 2 Hours**

Q1. An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

a) What is meant by *rational agents* in Artificial Intelligence (AI). [10 marks]

b) State the difference between *simple reflex agents* and *model based reflex agents.* [16 marks]

c) List and describe the four components necessary to define a problem formally. [24 marks]

d) Describe the following four properties of task environment:

i. Fully observable;

ii. Deterministic;

iii. Static;

iv. Discrete. [24 marks]

e) A library has deployed a robot to organise books on the bookshelves. Robot moves from desk to desk and picks up the books that have not been used for more than ten minutes. The robot notes the picked-up books and the books on the table. The robot keeps the picked-up books in a box attached to it. If the attached box is full, the robot will retrieve details from the database server and identifies the appropriate bookshelf and shelf the books accordingly. Robot will

continually do these tasks to keep tables tidy and arranged the books correctly in the bookshelves.

Identify the PEAS properties to describe the above task environment. [26 marks]

Q2. *Informed search strategies* are generally able to find solutions more efficiently than an uninformed strategy.

a) Briefly explain the following search strategies in plain English:

i. Greedy best-first search

ii. A* search [20 marks]

b) State the purpose of a *heuristic* function in informed search strategies. [10 marks]

c) *Hill-climbing* is a standard iterative improvement algorithm similar to greedy best-first search. Briefly describe the primary drawbacks with *hill-climbing*. [20 marks]

d) Consider the 8-puzzle game where the agent moves the numbered tiles on the board such that the tiles will be arranged in a predefined way. An initial arrangement of the board and the goal are given in the following figures:

Initial state

8	5	2
7	3	4
6		1

Goal state

8	5	2
7	4	1
6	3	

i. Draw a state space showing all possible states to move from initial state to goal state. [15 marks]

ii. Indicate the path that lead to the goal state from the start state. [10 marks]

iii. Specify which of the paths the *depth-first* search would find first and specify which one the *breadth-first* search would find first. [10 marks]

iv. Suggest a heuristic function to make a move, with justification, which can be used in *best-first search* algorithm. [15 marks]

Q3. Knowledge-based agents have the mechanism for reasoning from internal representation of knowledge.

a) Define *Universal quantification* and *Existential quantification.* Provide appropriate example for each. [20 marks]

b) Explain with a suitable example that the *Universal quantification* and *Existential quantification* are connected to each other through *negation.* [12 marks]

c) Convert the following into English sentences.

i. $\forall_X$ gardener (X) $\rightarrow$ likes (X, Sun)

ii. $\forall_X$ ((student (X) & result_AI (X, A) $\rightarrow$ happy (X)))

iii. (($\neg \exists_X$ (grocery_store (X) $\wedge$ own (Mary, X))) $\rightarrow \neg$ date (Mary, John))

iv. $\forall_X \forall_Y$ (nice (X) $\wedge$ rough (Y) $\rightarrow \neg$ date (X, Y)) [20 marks]

d) Consider the following paragraph:

All hounds howl at night. Anyone who has any cat will not have any mice. Light sleepers do not keep anything which howls at night. John has either a cat or a hound.

i. Translate these statements into statements in *predicate logic.* [20 marks]

ii. Convert the predicates of part (i) into clause form. [16 marks]

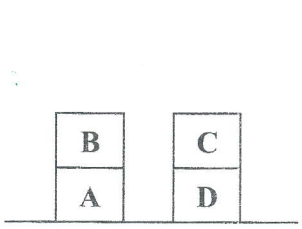
iii. Prove that "*If John is a light sleeper, then John does not have any mice*" using resolution. [12 marks]

Q4. Planning is a key ability for intelligent systems, increasing their autonomy and flexibility through the construction of sequences of actions to achieve their goals.

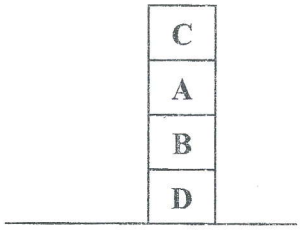
a) Write the precondition, delete-lists and add-lists for each operator of the *STRIPS* (*STanford Research Institute Problem Solver*) in the blocks world domain.

[36 marks]

b) Consider the following blocks world problem.



Initial state



Goal state

ON(B,A) ∧ ON(C,D) ∧
ONTABLE(A) ∧ ONTABLE(D) ∧
CLEAR(B) ∧ CLEAR(C) ∧
ARMEMPTY

ON(B,D) ∧ ON(A,B) ∧ ON(C,A)
ONTABLE(D) ∧ CLEAR(C)

Show how *Goal Stack Planning* may be used to solve the above block world problem. [64 marks]