THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME: LEVEL 05
FINAL EXAMINATION: SEMESTER 2 - 2017/2018
CPU3243: PRINCIPLES AND TECHNIQUES OF ARTIFICIAL INTELLIGENCE

DURATION: **THREE HOURS** (3 HOURS)

DATE: 05.04.2019	TIME: **2.00 p.m. to 5.00 p.m.**

Answer FOUR Questions ONLY.

Q1.

(a) Define the term **Artificial Intelligence (AI)**.

(b) Give an example of system that:

    (i) Think like humans

    (ii) Thinks rationally

    (iii) Act like humans

    (iv) Acts rationally

(c) What is the goal of the **Turing test**?

(d) Briefly describe on:

    (i) Foundations of AI

    (ii) Applications of AI

(e)

    (i) What is **reasoning**?

    (ii) Compare and contrast **deterministic** and **non-deterministic** reasoning.

    (iii) Explain seven types of reasoning techniques with suitable examples.

Q2.

(a) Briefly explain the following terms.

    (i) Tautology

    (ii) Contradiction

    (iii) Model assignment

    (iv) Counter example

(b) Draw the truth tables for the following propositional formulas, and indicate whether each statement is a tautology, a contradiction, or neither.

    (i) $(P \lor \neg Q) \to (Q \land R)$

(ii) $\left((A \to B) \wedge (B \to \neg A)\right) \to A$

(iii) $(\neg B \to \neg A) \to \left((\neg B \to A) \to B\right)$

(iv) $(P \leftrightarrow Q) \wedge (\neg P \wedge Q)$

(c) Translate the following English sentences into propositional logic formulas

    (i) When the front and back doors are closed then the light is off.

    (ii) Either the lift doors are open or the lift is moving and the lift doors are closed.

    (iii) Mathematics is easy or camping is fun, as long as it is sunny and the homework is done.

(d) Define the **conjunctive normal form** and the **disjunctive normal form**.

(e) Transform the following formulas into conjunctive normal form:

    (i) $P \leftrightarrow Q$

    (ii) $(P \wedge Q) \leftrightarrow (P \vee Q)$

    (iii) $P \wedge (P \to Q) \to Q$

Q3.

(a)

    (i) Differentiate between the **propositional logic** and the **predicate logic**?

    (ii) Describe how predicate logic addresses the limitations of propositional logic.

(b) Briefly explain the following terms in first-order logic.

    (i) Variable

    (ii) Predicate symbol

    (iii) Constant

    (iv) Function symbol

    (v) Term

    (vi) Atom

(c) Translate the following sentences in first-order logic.

    (i) Everyone loves Mary

    (ii) Everyone loves someone

    (iii) Every student who walks talks

    (iv) Every student who loves Mary is happy

    (ii)   Everyone loves someone

    (iii)   Every student who walks talks

    (iv)   Every student who loves Mary is happy

(d)

    (i)   What is meant by **prenex normal form**?

    (ii)   Find the prenex normal form of the following formulas:

        a) $\neg \forall x \big[(\forall x \, P(x)) \rightarrow R(x) \big]$

        b) $\exists x \big[(\forall x \, P(x)) \wedge \neg R(x) \big]$

        c) $\forall x \big(\exists y \, R(x,y) \wedge \forall y \neg S(x,y) \rightarrow \neg (\exists y \, R(x,y) \wedge P) \big)$

Q4.

(a)   Which instruments are used for perceiving and acting upon the environment?

(b)   What is meant by **rational agent**?

(c)   Briefly explain the following terms relating to intelligent agents:

    (i)   Rationality

    (ii)   Autonomous

    (iii)   Information gathering

    (iv)   Learn

(d)   "When defining a rational agent, we had to specify the performance measure, the environment, and the agent's sensors and actuators." Write PEAS description for the following automated agents.

    (i)   Taxi driver

    (ii)   Medical diagnosis system

(e)

    (i)   List some environmental properties that are important for intelligent agents.

    (ii)   Briefly explain two (02) properties given in the question (e)(i).

    (iii)   List two (02) environment properties for the following agents.

        a) Vacuum cleaner

        b) Taxi driver

        c) Crossword puzzle

        d) Chess

(f) Briefly explain the following agents, and give one example for each.

   (i)   Simple reflex agent

   (ii)   Model based reflex agent

   (iii) Goal based agent

   (iv)   Utility based agent

Q5.

(a) "Problem solving agents find some sequence of actions to achieve a goal state in a best way." How do they achieve a goal in a best way? Explain using an example.

(b) Define the following terms with regard to problem solving agents.

   (i)   Initial state

   (ii)   Successor function

   (iii) State space

(c) Consider the eight puzzles (8-puzzles) shown in the figure 1. Define the standard formulation for the problem under the following terms:

   •   States

   •   Initial state

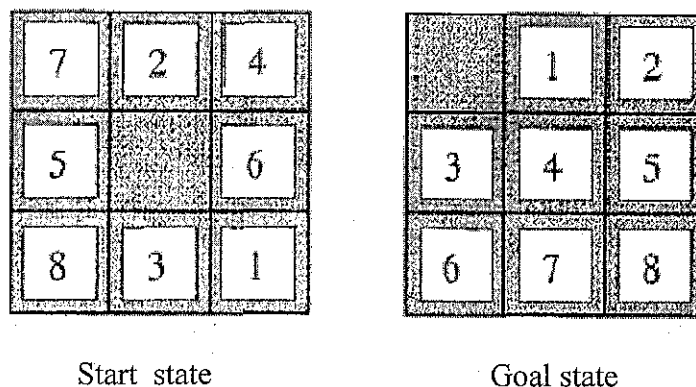   •   Successor function

   •   Goal test

   •   Path cost

Start state   Goal state

Figure 1: The typical instances of the 8-puzzles

(d) What are the **Incremental formulation** and the **Complete-state formulation** of the eight queens problem?

(e) Briefly explain the following search strategies.

    (i)   Breadth-first search

    (ii)   Depth first search

    (iii) Bidirectional search

(f) State the completeness and the optimality of the search algorithms given in question (e).

(g) Breadth-first search can be thought of as a special case of uniform cost search. Briefly explain your answer.

Q6.

(a)

    (i)   Describe the difference between **Prolog** and **normal programming language**.

    (ii)   Explain facts, rules and variables in Prolog.

    (iii) Explain the recursion in Prolog.

    (iv) Name three (03) data types in Prolog programming language.

(b) Suppose that you have the following family tree in Prolog.

```
male(buford).
male(ben).
male(larry).
male(jesse).
male(james).
male(benard).

female(latoya).
female(kamelia).
female(amelia).
female(amy).
female(bessie).
female(albertine).

parent(larry, latoya).
parent(larry, buford).
parent(larry, kamelia).
parent(jesse, larry).
parent(benard, ben).
parent(james, amelia).
parent(amelia, latoya).
parent(amelia, buford).
parent(amelia, kamelia).
parent(amy, larry).
parent(bessie, amelia).
parent(albertine, ben).
```

(i) Provide a definition for mother/2, father/2, brother/2, and sister/2.

(Assume that, all these rules have the standard meanings as their names imply.)

(ii) Further, you have the following recursive definition of "ancestor":

```
ancestor(X,X).
ancestor(X,Z) :- parent(X,Y), ancestor(Y,Z).
```

Then, consider the output of the following statement.

```
?- ancestor(A,B).
```

Each time that Prolog returns an answer, the user inputs ' ; ' to ask it to look for another answer.

What answers does Prolog return, and in what order?

(c) Explain the difference between bagof/3 and setof/3 predicates in Prolog.

(d) By using the following user defined member list predicate,

```
member( H, [H | _] ).
member( H, [_ | T] ) :- member (H, T).
```

Trace the output of the following statement.

```
?- member(Ringo, [John, Paul, Ringo, George])
```