THE OPEN UNIVERSITY OF SRI LANKA
BSc DEGREE PROGRAMME: LEVEL 05
FINAL EXAMINATION: SEMESTER 2 - 2023/2024
CSU5308/CSU5317: ARTIFICIAL INTELLIGENCE
DURATION: **TWO HOURS** (2 HOURS)

DATE: **20.03.2024** TIME: **9.30 a.m. to 11.30 a.m.**

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Answer FOUR Questions ONLY.

Q1.

(a) Define the following terms in your own words.

(i) Intelligence

(ii) Rationality

(iii) Thinking rationally

(iv) Acting rationally

[04 marks]

(b) Briefly explain the **Turing Test** with three (03) capabilities in which the computers should possess in order to pass the Turing Test.

[06 marks]

(c) Name two (02) **viewpoints or techniques** extracted from the following disciplines to Artificial Intelligence.

(i) Philosophy

(ii) Mathematics

(iii) Economics

[06 marks]

(d) Explain in your own words the following types of reasoning and give one (01) example for each.

(i) Deterministic reasoning

(ii) Dynamic reasoning

(iii) Non-deterministic reasoning

[09 marks]

Q2.

(a) Convert the following English sentences to **Propositional Logic** statements.

(i) I like bread but do not like cake.

(ii) Kanthi goes to parties only if Sunil goes with her.

(iii) I do not eat cookies and fries.

(iv) It is raining if and only if Wimala is sick.

[08 marks]

(b) Differentiate between the **conjunctive normal form** and **disjunctive normal form**.

[05 marks]

(c) Use the truth table to determine whether the following statement is **satisfiable**.

$$(\neg P \vee Q) \wedge (Q \rightarrow \neg R \wedge \neg P) \wedge (P \vee R)$$

[06 marks]

(d) Convert the following Propositional Logic statements to **conjunctive normal form**.

(i) $\neg(\neg P \vee Q) \vee (R \rightarrow \neg S)$

(ii) $(\neg P \rightarrow Q) \rightarrow (Q \rightarrow \neg R)$

[06 marks]

Q3.

(a) State whether the following statements are **well formed formulas** or not.

(i) $q(x, p(a), b)$

(ii) $\neg r(x, a)$

(iii) $r\big(a, g(a, a)\big)$

(iv) $\forall x \neg p(x)$

(v) $a \rightarrow p(b)$

[05 marks]

(b) Find **free variables** in the following formulas.

(i) $p(x) \wedge \neg r(y, a)$

(ii) $\forall x \exists y\, r\big(x, f(y)\big)$

(iii) $\forall z \left(p(z) \rightarrow \exists y \left(\exists x\, q(x, y, z) \vee q(z, y, x)\right)\right)$

[03 marks]

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

[04 marks]

(d) Which of the following formulas are in prenex normal form?

(i) $\forall x P(x) \vee \forall x Q(x)$

(ii) $R(x, y)$

(iii) $\forall x \exists y R(x, y)$

[03 marks]

(e) Transform the following formulas into **prenex normal form**.

(i) $(\forall x) P(x) \rightarrow (\exists x) Q(x)$

(ii) $\neg\big[\forall x \exists y F(u, x, y) \rightarrow \exists x\big(\neg \forall y G(y, v) \rightarrow H(x)\big)\big]$

[10 marks]

Q4.

(a) Define **problem-solving agent** in your own words.

[03 marks]

(b) When designing a problem-solving agent, it uses three procedures as **search**, **solution**, and **execution**. Explain in your own words how these three (03) procedures connect to each other.

[06 marks]

(c) Define the following components of a problem.

(i) Initial state

(ii) Successor function

(iii) State space

[06 marks]

(d) Define the **states, initial state, successor function, goal test,** and **path cost** for the following problems.

(i) Vacuum Cleaner World

(ii) 8 - puzzle

[10 marks]

Q5.

(a) What is the difference between **Prolog** and other programming languages?

[5 marks]

(b) Define the following terms in Prolog using examples.

(i) Atom

(ii) Structure

(iii) Variable

[6 marks]

(c) Differentiate between the `setof` and `bagof` predicates in Prolog.

[4 marks]

(d) Consider the following Prolog program to answer the queries given below in the questions (i) and (ii). For each query, list all the substitution(s)/answers that make the query true.

```
:- dynamic student/3, subject/3, score/5.

student(1, 'Nimal', 'Computer').
student(2, 'Saman', 'Chemistry').
student(3, 'Kamal', 'Physics').

subject(1, 'Mathematics', 'Ms. Karuna').
subject(2, 'Music', 'Ms. Padma').
```

```
subject(3, 'Science', 'Mr. Thinul').

score(1, 1, 1, 70, 'Theory', '100').
score(4, 2, 1, 60, 'Theory', '100').
score(7, 3, 1, 65, 'Theory', '100').

printList([]).
printList([H|T]):-student(H,N,B),write(N),write('
'),write(B),nl,printList(T).

printStu:- write('----------------------'),nl,
           write('     List of Students    '), nl,
           write('----------------------'), nl,
           write('name            Branch'), nl,
           write('----------------------'),nl,
           setof(S, N^B^student(S,N,B),L), printList(L).
```

(i) `?- student(A,B,C).`

(ii) `?- printStu.`

[10 marks]

Q6.

(a) Explain the following terms in Prolog with an example.

(i) Atoms

(ii) Variables

(iii) Structures

[03 marks]

(b) What is the output of the following matching statement?

```
?- date(D,M,2010)=date(D1,May,Y1).
```

[05 marks]

(c) Consider the following user defined member list predicate to answer the following question.

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

Trace the output of the following statement.

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

[07 marks]

(d) Consider the following family tree in Prolog to answer the questions given below.

```
parent(rathnapala, sunil).
parent(rathnapala, kamala).
parent(rathnapala, gamini).
parent(rathnapala, ruwini).
parent(gunadasa,  tikiri).

male(rathnapala).
male(sunil).
male(gamini).
```

```
female(kamala).
female(ruwini).
female(tikiri).
```

(i) Create the following Prolog rules.

```
son/2, daughter/2, mother/2, father/2
```

(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 do Prolog return, and in what order?

[10 marks]