CONFIDENTIAL

FINAL EXAMINATION
SEPTEMBER/OCTOBER SEMESTER 2014

BACHELOR OF COMPUTER SCIENCE (HONS)
BACHELOR OF INFORMATION TECHNOLOGY (HONS)
IN SOFTWARE ENGINEERING

ARTIFICIAL INTELLIGENT
(BTT 307)

(TIME : 3 HOURS)

MATRIC NO. :

IC. / PASSPORT NO. :

LECTURER : **NORADIBAH ADNAN**

GENERAL INSTRUCTIONS

1. This question booklet consists of 7 printed pages including this page.
2. Answer **ALL questions** in the **ANSWER BOOKLET**

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INSTRUCTIONS: **TIME: 3 *HOURS***

SECTION A **(55 MARKS)**

There are THREE (3) questions in this section. Answer ALL Questions in the Answer Booklet.

1. Agents are comprised of an architecture plus a program that runs on that architecture. In designing the programs with the intelligent systems there are four main factors to consider. The earlier agent design named as PAGE descriptors (Percepts, Actions, Goals, Environment). However, the PAGE descriptors are not the unique way of describing intelligent systems and the popular alternative involves PEAS descriptors (Performance, Environment, Actuators, Sensors).

   a) Define the elements of PAGE descriptors

   (4 Marks)

   b) In designing an agent, the PEAS descriptors able to specify the task environment that focus to problems and solutions rather than the PAGE descriptors. Explain your answer that based on the elements in PEAS descriptors.

   (8 Marks)

   c) Consider the following situation:

   An autonomous car also known as a driverless car self-driving car or robotic car is an autonomous vehicle capable of fulfilling the transportation capabilities of a traditional car. As an autonomous vehicle, it is capable of sensing its environment and navigating without human input.

   Write the PEAS description of the task environment for an automated taxi. Identify at least two examples for every elements.

   (10 Marks)

2. Before an agent can start searching for solutions, a goal must be identified and a well-defined problem must be formulated. The environment of the problem is represented by a state space. A path through the state space from the initial state to a goal state is a solution.

   a) Define in your own words the following terms: state, state space and search tree.

   (6 Marks)

b) Given a complete problem formulation for the following. Choose a formulation to be implemented based on the factors of initial state, goal test, action/successor functions and path cost:

Using only four colors, you have to color a planar map in such a way that no two adjacent regions have the same color.

(8 Marks)

c) Consider a state space where the start state is number 1 and each state x has two successors: numbers $2x$ and $2x + 1$. Assuming the step cost is 1.

i. Draw the portion of the state space for states 1 to 7.

(4 Marks)

ii. Suppose the goal state is 5. List the order in which nodes will be visited for breadth first search, uniform-cost search, and depth-limited search with limit 2.

(5 Marks)

3. Propositional logic is a simple language consisting of proposition symbols and logical connectives. It can handle propositions that are known true, known false, or completely unknown.

a) Prove each of the following assertions:
   i. α is valid if and only if True $\models \alpha$.
   ii. $\alpha \models \beta$ if and only if the sentence $(\alpha \Rightarrow \beta)$ is valid.
   iii. $\alpha \models \beta$ if and only if the sentence $(\alpha \land \neg\beta)$ is unsatisfiable.

(6 Marks)

b) Decide whether each of the following sentences is valid, unsatisfiable, or neither. Verify your decisions using truth tables or the equivalence rules of Figure 1.1.

$$
\begin{array}{rcll}
(\alpha \wedge \beta) & \equiv & (\beta \wedge \alpha) & \texttt{commutativity of } \wedge \\
(\alpha \vee \beta) & \equiv & (\beta \vee \alpha) & \texttt{commutativity of } \vee \\
((\alpha \wedge \beta) \wedge \gamma) & \equiv & (\alpha \wedge (\beta \wedge \gamma)) & \texttt{associativity of } \wedge \\
((\alpha \vee \beta) \vee \gamma) & \equiv & (\alpha \vee (\beta \vee \gamma)) & \texttt{associativity of } \vee \\
\neg(\neg\alpha) & \equiv & \alpha & \texttt{double-negation elimination} \\
(\alpha \Rightarrow \beta) & \equiv & (\neg\beta \Rightarrow \neg\alpha) & \texttt{contraposition} \\
(\alpha \Rightarrow \beta) & \equiv & (\neg\alpha \vee \beta) & \texttt{implication elimination} \\
(\alpha \Leftrightarrow \beta) & \equiv & ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)) & \texttt{biconditional elimination} \\
\neg(\alpha \wedge \beta) & \equiv & (\neg\alpha \vee \neg\beta) & \texttt{De Morgan} \\
\neg(\alpha \vee \beta) & \equiv & (\neg\alpha \wedge \neg\beta) & \texttt{De Morgan} \\
(\alpha \wedge (\beta \vee \gamma)) & \equiv & ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma)) & \texttt{distributivity of } \wedge \texttt{ over } \vee \\
(\alpha \vee (\beta \wedge \gamma)) & \equiv & ((\alpha \vee \beta) \wedge (\alpha \vee \gamma)) & \texttt{distributivity of } \vee \texttt{ over } \wedge
\end{array}
$$

Figure 1.1 Standard logical equivalences. The symbols α, β, and γ stand for arbitrary sentences of propositional logic.

i. Smoke $\Rightarrow$ Fire
ii. (Smoke $\Rightarrow$ Fire) $\Rightarrow$ ($\neg$Smoke $\Rightarrow$ $\neg$Fire)
iii. Smoke $\vee$ Fire $\vee$ $\neg$Fire
iv. ((Smoke $\wedge$ Heat) $\Rightarrow$ Fire) $\Leftrightarrow$ ((Smoke $\Rightarrow$ Fire) $\vee$ (Heat $\Rightarrow$ Fire))

(4 Marks)

SECTION B **(45 MARKS)**

There are THREE (3) questions in this section. Answer ALL questions in the Answer Booklet. This section consist programming in PROLOG.

1. Consider the following prolog syntax:

```
happy(vincent).
listens2music(butch).
playsAirGuitar(vincent):- listens2music(vincent), happy(vincent).
playsAirGuitar(butch):- happy(butch).
playsAirGuitar(butch):- listens2music(butch).
```

   a) Identify facts, rules and predicates from the above syntax:

   (3 Marks)

   b) What does the following query produce? Explain your answer if the syntax can be deduced.

      i. `?- playsAirGuitar(vincent).`

      ii. `?- playsAirGuitar(butch).`

   (4 Marks)

2. Consider the following prolog syntax:

```
woman(mia).
woman(jody).
woman(yolanda).

loves(vincent, mia).
loves(marsellus, mia).
loves(pumpkin, honey_bunny).
loves(honey_bunny, pumpkin).
```

   a) How do you add the following rules?

      i. An individual X is in loves with an individual Y if an individual Y is also loves an individual X.

      ii. An individual X will be jealous of an individual Y if there is some individual Z that X loves, and Y loves that same individual Z too.

   (4 Marks)

b) How do you pose query for the following:

i. Which of the individuals you know about is a woman.

ii. Which of the individuals is loves mia.

(4 Marks)

c) Referring to your answer in question 2.a.ii,

i. How do you pose query for which of the individual W such that Marsellus is jealous of W?

(2 Marks)

ii. Draw the search tree.

(14 Marks)

3. Consider the following family tree:

```
                              James I
                                 |
              +------------------+------------------+
              |                                     |
           Charles I                            Elizabeth
              |                                     |
   +----------+------------+                     Sophia
   |          |            |                        |
Catherine  Charles II   James II                 George I
```

Here are the resultant clauses:

```
male(james1).
male(charles1).
male(charles2).
male(james2).
male(george1).

female(catherine).
female(elizabeth).
female(sophia).

parent(james1,charles1).
parent(james1,elizabeth).
parent(charles1,charles2).
parent(charles1,catherine).
parent(charles1,james2).
parent(elizabeth,sophia).
parent(sophia,george1).
```

a) How would you formulate the following queries:

i. Was George I the parent of Charles I?

ii. Who was Charles I's parent?

iii. Who were the children of Charles I?

(6 Marks)

b) Write the following rules:

i. M is the mother of X if she is a parent of X and is female

ii. F is the father of X if he is a parent of X and is male

iii. X is a sibling of Y if they both have the same parent.

iv. X is the grandparent of Y if X is a parent of Z and Z is a parent of Y

(8 Marks)

***** END OF QUESTIONS *****