



MZUZU UNIVERSITY

FACULTY OF SCIENCE, TECHNOLOGY AND INNOVATION

DEPARTMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY

BACHELOR OF SCIENCE IN INFORMATION AND COMMUNICATION TECHNOLOGY

ICT 4801: ARTIFICIAL INTELLIGENCE

END OF SEMESTER EXAMINATION

DATE: JULY, 2019

TIME ALLOWED: 3 HOURS

INSTRUCTIONS

1. Answer **ALL** questions.
2. Marks for each question are indicated.
3. Write your answers clearly.
4. Indicate the question number for each answer..
5. This paper contains **THREE** pages. Please check.

- 1.
- a. In your own words define the following terms and derivatives, from Artificial Intelligence perspective
- i. Agent *and* Agent Function. [4 marks]
 - ii. State *and* State Space. [4 marks]
- b. Show how each of the following statements could be true
- i. Breadth-first search is a special case of uniform-cost search. [2 marks]
 - ii. Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search. [6 marks]
 - iii. Uniform-cost search is a special case of A* search. [2 marks]
- c. The heuristic path algorithm is the best-first search in which the objective function is invented as $f(n) = (2 - w) \left[g(n) + \frac{w}{2-w} h(n) \right]$ where $g(n)$ and $h(n)$ carry their usual meanings.
- i. Assuming $h(n)$ is admissible, for what values of w is this algorithm guaranteed to be optimal? [3 marks]
 - ii. What kind of search does this algorithm perform when $w = 0$ and when $w = 2$? [4 marks]
2. Consider a state space where the start state is the number 1 and the successor function for state n returns two states, namely, numbers $2n$ and $2n+3$.
- a. Draw the portion of the state space to a depth of 4. [5 marks]
- b. What is the size of the state space? [1 marks]
- c. Suppose the goal state is 55. List the order in which nodes will be visited for
- i. Breadth-first search. [2 marks]
 - ii. Depth-limited search with limit 4. [6 marks]
 - iii. Iterative deepening search. [9 marks]
- d. What is the branching factor in each direction if the bidirectional search is used? [2 marks]

3. Using your understanding of propositional logic syntax/semantics and/or sample rules of inference answer the following questions.
- a. Entailment (\models) is an important concept in propositional logic. Define the following concepts in terms of the entailment concept.
- i. Equivalence of any two sentences ($\alpha \equiv \beta$). [3 marks]
 - ii. Deduction theorem ($\alpha \Rightarrow \beta$). [2 marks]
- b. Prove the following assertions
- i. α is valid if and only if $True \models \alpha$. [4 marks]
 - ii. $\alpha \models \beta$ if and only if the sentence $(\alpha \wedge \neg\beta)$ is unsatisfiable. [4 marks]
- c. Resolution inference algorithm proves that a knowledge base, KB , entails a query, Q if $KB \wedge \neg Q$ is unsatisfiable. Prove that $KB = (\alpha \Leftrightarrow (\beta \vee \theta)) \wedge \neg\alpha$ entails $Q = \neg\beta$. [12 marks]
4. Represent the following sentences in **First-Order Logic** using a consistent vocabulary defined in **Table 1** in **Appendix A**.
- a. Some students took History in Semester6. [2 marks]
 - b. Every student who takes History passes it. [3 marks]
 - c. Only one student took Physics in Semester6. [5 marks]
 - d. The best score in History is always greater than the best score in Physics. [4 marks]
 - e. A person born in Malawi, each of whose parents is a Malawi citizen or a Malawi resident, is a Malawi citizen by birth. [6 marks]
 - f. Politicians can fool some of the people all of the time, and they can fool all of the people some of the time, but they can't fool all the people all the time. [5 marks]

Appendix A

Table 1: Basic Vocabulary

<i>P</i>	: Physics
<i>H</i>	: History
<i>S6</i>	: Semester6
<i>Mlw</i>	: Malawi
<i>Br</i>	: Birth
<i>Takes(x,c,s)</i>	:student <i>x</i> takes course <i>c</i> in semester <i>s</i>
<i>Passes(x,c,s)</i>	:student <i>x</i> passes course <i>c</i> in semester <i>s</i>
<i>Fools(x,y,t)</i>	:person <i>x</i> fools person <i>y</i> at time <i>t</i>
<i>Score(x,c,s)</i>	:student <i>x</i> passes course <i>c</i> in semester <i>s</i>
<i>Born(x,c)</i>	:person <i>x</i> is born in country <i>c</i>
<i>Parent(x,y)</i>	: <i>x</i> is parent of <i>y</i>
<i>Resident(x,c)</i>	: <i>x</i> is a resident of country <i>c</i>
<i>Citizen(x,c,r)</i>	: <i>x</i> is citizen of country <i>c</i> for reason <i>r</i>
<i>x > y</i>	: <i>x</i> is greater than <i>y</i>
<i>Person(x), Student(x), Politician(x)</i>	: predicates satisfied by members of the corresponding categories

END OF QUESTION PAPER