NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE	
QUALIFICATION CODE: 07BACS	LEVEL: 7
COURSE: ARTIFICIAL INTELLIGENCE AND COMPUTER GRAPHICS	COURSE CODE: AIG710S
SESSION: June 2019	PAPER: Theory
DURATION: 3 Hours	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER:	Prof. José G. Quenum
MODERATOR:	Mr Simbarashe Nyika

This paper consists of 3 pages
(excluding this front page)

INSTRUCTIONS

1. This paper contains 5 questions.
2. Answer all questions on the exam paper.
3. Marks/scores are provided at the right end of each question
4. Do not use or bring into the examination venue books, programmable calculators, mobile devices and other materials that may provide you with unfair advantage. Should you be in possession of one right now, draw the attention of the examiner officer or the invigilator.
5. NUST examination rules and regulations apply.

PERMISSIBLE MATERIALS

None

Question 1 .... [10 points]

Consider a vacuum cleaner problem-solving agent whose static environment consists of three (3) squares, `Square-A`, `Square-B` and `Square-C`; with `Square-A` on the left-hand side, `Square-B` in the middle and `Square-C` on the right-hand side. The vacuum cleaner can take four (4) possible actions: move right (`R`), move left (`L`), clean dirt (`C`) and remain in the current square (`Re`). More specifically, when in a given square, the agent can move left only if there is a square to its left, move right only if there is a square to its right and clean only when there is dirt in the square. The goal state is a state where there is no dirt in any of the squares.

Assuming that the vacuum cleaner is initially in `Square-A` and that there is dirt in all squares, show the tree of actions leading to the goal state. Note that no action is possible once the goal state is reached.

Question 2 .... [40 points]

(a) Consider a problem $\mathcal{Q}$ defined as follows: [10]

- initial state: S;
- actions: $\{a_0, a_1, a_2, a_3, a_4, a_5, a_6, a_7\}$;
- transition model: as depicted in Table 1;
- goal test: $\forall W : State, W = G$;
- path cost and heuristic: as indicated in Table 1.

Table 1: Transition Model and Heuristic

State		Transition		-	State		Transition	
Name	Heuristic	Tuple	Cost		Name	Heuristic	Tuple	Cost
S	4	(S, a_0, A)	1		A	2	(A, a_2, C)	1
		(S, a_1, G)	12				(A, a_3, B)	3
C	2	(C, a_5, G)	2		B	6	(B, a_4, D)	3
		(C, a_6, D)	2					
D	3	(D, a_7, G)	3		G	0		

Note that a tuple (S_i, a_ℓ, S_j) in the transition column in Table 1 depicts a deterministic transition, where S_j and S_i are states and a_ℓ an action.

Using the A* search strategy, find a solution to $\mathcal{Q}$.

(b) We would like to organise a one-day workshop with seven (7) speakers: $\{Speaker_1, Speaker_2, Speaker_3, Speaker_4, Speaker_5, Speaker_6, Speaker_7\}$. Each speaker can have his/her presentation during one of the following time slots: T_1, T_2, T_3 and T_4. $Speaker_3$ can only speak during T_1. $Speaker_1$ cannot speak during the same time slot as any other speaker, except for $Speaker_7$. As well, $Speaker_4$ cannot speak during the same time slot as $\{Speaker_3, Speaker_6, Speaker_5\}$. Moreover, $Speaker_2$ cannot share the same time slot as $Speaker_5$. Finally, $Speaker_6$ cannot speak during the same time slot as $Speaker_7$ and $Speaker_5$. [15]

Using a combination of forward checking and propagation provide the time slot to be allocated to each speaker.

(c) Using the $\alpha - \beta$ pruning technique, solve the adversarial game depicted in Figure 1. [15]

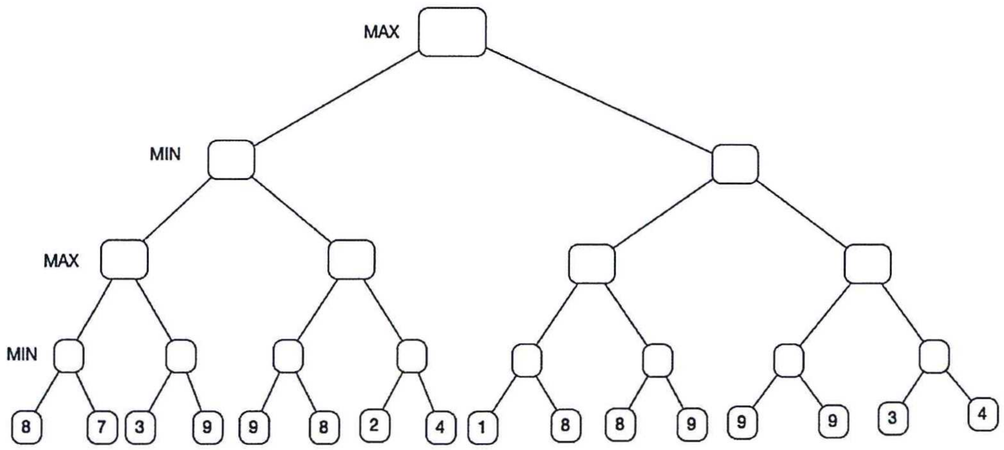

Figure 1: Adversarial Search Problem

Question 3 .... [25 points]

(a) Consider the following Roman story: [10]

Marcus was a man. He was actually a Pompeian. All Pompeian were Romans. Caesar was a ruler. All Romans were either loyal to Cease or hated him. Everyone is loyal to someone. Men only try to assassinate rulers they are not loyal to. Marcus tried to assassinate Cesar.

Using First-order Logic, answer the following two questions:

- Was Marcus a Roman?
- Was he loyal to Cesar?

(b) Consider the blocks world. Here we have five (5) blocks: A, B, C, D and E. There is also a table with a capacity of three (3) blocks (i.e., three distinct blocks can lay on the table at any point in time simultaneously). It is assumed that a block can either be inside the box or outside. When outside the box, a block can either be on the table or on top of another block. [15]

We have the following predicates:

$ontable(\mathtt{x})$: the block x is on the table;

$on(\mathtt{x}, \mathtt{y})$: the block x lays on top of the block y;

$clear(\mathtt{x})$: the block x is clear, i.e., there is nothing on top of it;

$inbox(\mathtt{x})$: the block x is inside the box.

Moreover, the following actions are introduced:

$pick(\mathtt{x})$: which picks a block from the box and drops it on the table;

$drop(\mathtt{x,y})$: which drops the block on either the table or another block.

Consider a partial plan P containing two actions: a_0 and $a_\imath$, with $a_0 \prec a_\imath$. The action a_0 has the following effect:

$$ontable(\text{B}); clear(\text{B}); clear(\text{Table}); inbox(\text{A}); inbox(\text{C}); inbox(\text{D}); inbox(\text{E});$$

The action $a_\imath$ leads to a goal state and has the following pre conditions:

$$ontable(\mathsf{C}); ontable(\mathsf{A}); clear(\mathsf{Table}); on(\mathsf{B}, \mathsf{C}); on(\mathsf{D}, \mathsf{B}); on(\mathsf{E}, \mathsf{A});$$

Modify P to generate a complete and correct plan.

Question 4 .... [15 points]

(a) Consider a game $\mathcal{G}$ whose strategic form is represented as follows: [2]

		Player2		
		$\imath_1$	$\jmath_1$	ℓ_1
Player1	$\imath_0$	$(7,2)$	$(2,5)$	$(6,3)$
	$\jmath_0$	$(2,2)$	$(6,5)$	$(4,8)$
	ℓ_0	$(3,1)$	$(2,7)$	$(4,9)$

Is there a dominated strategy for Player 2? If yes eliminate it;

(b) The resulting game is now called $\mathcal{G}'$. Is ℓ_0 a worse strategy for Player 1 than playing a mixed strategy of $\imath_0$ and $\jmath_0$ in $\mathcal{G}'$? [6]

(c) what is the payoff of each player when they play a mixed strategy with Player 1 eliminating ℓ_0 in $\mathcal{G}'$? [7]

Question 5 .... [10 points]

Consider the following vectors:

$$\mathsf{X}_1 = \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix} \mathsf{X}_2 = \begin{bmatrix} 3 \\ 1 \\ 5 \end{bmatrix} \mathsf{X}_3 = \begin{bmatrix} 2 \\ 5 \\ 7 \end{bmatrix}$$

Perform the following operations:

- $\mathsf{X}_1\mathsf{X}_2$
- $\mathsf{X}_1 \times \mathsf{X}_2$
- $(\mathsf{X}_1 + \mathsf{X}_2) \times \mathsf{X}_3$
- the rotation of X_3 of $90°$