



# UNIVERSITI TEKNOLOGI MALAYSIA

## MID TERM TEST

**SEMESTER 1, 2024/2025**

**SUBJECT CODE : SECJ 3553**

**SUBJECT : ARTIFICIAL INTELLIGENCE**

**TIME : 2 HOURS**

**DATE : 2 DECEMBER 2024**

### INSTRUCTIONS TO STUDENTS:

This test book consists of 2 sections:

**Section A:** Multiple Choice Questions [30 Marks]

**Section B:** Theory and Applications [70 Marks]

**ANSWER ALL QUESTIONS IN THE ANSWER BOOKLET.**

<b>Name:</b>	
<b>Identity card (or Matric) No:</b>	
<b>Year / Course:</b>	
<b>Section:</b>	
<b>Lecturer Name:</b>	

This test book consists of 12 printed pages including this page.

**SECTION A TOTAL MARKS: 30**

*Choose the correct answer for the following questions. Each question carries 1.5 mark.*

1. What is the correct representation of "Some cats are black" in First Order Logic (FOL)?
  - a)  $\forall x (Cat(x) \wedge Black(x))$
  - b)  $\exists x (Cat(x) \rightarrow Black(x))$
  - c)  $\exists x (Cat(x) \wedge Black(x))$
  - d)  $\forall x (Cat(x) \rightarrow Black(x))$
  
2. If  $\exists x (Student(x) \wedge Studies(x))$ , which English sentence best represents this statement?
  - a) Every student studies.
  - b) Some students study.
  - c) No students study.
  - d) All students fail.
  
3. Examine the sentence "Everyone who likes mathematics likes logic." Which First Order Logic statement captures this?
  - a)  $\forall x (Likes(x, Mathematics) \rightarrow Likes(x, Logic))$
  - b)  $\exists x (Likes(x, Mathematics) \wedge Likes(x, Logic))$
  - c)  $\forall x (Likes(x, Mathematics) \wedge Likes(x, Logic))$
  - d)  $\exists x (Likes(x, Mathematics) \vee Likes(x, Logic))$
  
4. The predicate logic statement  $\forall x (Car(x) \rightarrow (Electric(x) \vee Hybrid(x)))$  translates to which of the following English sentences?
  - a) "Some cars are either electric or hybrid."
  - b) "All cars are either electric or hybrid."
  - c) "All cars are electric and hybrid."
  - d) "If a car is electric, then it is hybrid."
  
5. How would you represent the sentence "There exists a person who is both a doctor and a teacher"?
  - a)  $\forall x (Person(x) \wedge Doctor(x) \wedge Teacher(x))$
  - b)  $\exists x (Person(x) \wedge (Doctor(x) \vee Teacher(x)))$
  - c)  $\exists x (Doctor(x) \wedge Teacher(x))$

- d)  $\forall x (\text{Doctor}(x) \Rightarrow \text{Teacher}(x))$
6. Translate 'There is no person who is both rich and unhappy' into First Order Logic (FOL).
- $\exists x (\text{Rich}(x) \wedge \text{Unhappy}(x))$
  - $\forall x (\text{Rich}(x) \Rightarrow \neg \text{Unhappy}(x))$
  - $\neg \exists x (\text{Rich}(x) \wedge \text{Unhappy}(x))$
  - $\forall x (\neg \text{Rich}(x) \vee \text{Unhappy}(x))$
7. Which of the following represents the statement 'For every person, there is someone they trust'?
- $\exists x \exists y (\text{Person}(x) \wedge \text{Trusts}(x, y))$
  - $\forall x \exists y (\text{Person}(x) \Rightarrow \text{Trusts}(x, y))$
  - $\exists x \forall y (\text{Trusts}(x, y))$
  - $\forall x \exists y (\text{Person}(x) \wedge \text{Trusts}(x, y))$
8. Which of the following is the correct application of De Morgan's Law to the expression  $\neg(P \wedge Q)$ ?
- $\neg P \vee \neg Q$
  - $\neg P \wedge \neg Q$
  - $\neg P \rightarrow \neg Q$
  - $P \vee Q$
9. Which of the following is the correct conclusion when applying **Modus Ponens** to the statements:
- If it rains, the ground will be wet. ( $P \rightarrow Q$ )
  - It is raining. ( $P$ )
- The ground will not be wet ( $\neg Q$ )
  - It is not raining ( $\neg P$ )
  - The ground will be wet ( $Q$ )
  - It will not rain ( $\neg P$ )
10. Given the following premises:
- If a person is a student, then they are enrolled in at least one course.  
( $\forall x (\text{Student}(x) \rightarrow \exists y (\text{EnrolledIn}(x, y)))$ )
  - Alice is a student. ( $\text{Student}(\text{Alice})$ )

3. If a person is enrolled in a course, then they have access to course materials.

$$(\forall x(\exists y(\text{EnrolledIn}(x,y)) \rightarrow \text{HasAccessToCourseMaterials}(x)))$$

**Task:** Using **Universal Elimination**, **Modus Ponens**, and **And Introduction**, what can you conclude about Alice?

- a) Alice has access to course materials.
- b) Alice is not enrolled in any course.
- c) Alice is a student but does not have access to course materials.
- d) Alice is enrolled in at least one course but does not have access to course materials.

11. Given the following premises:

1. For every person x if x is a teacher, then x has a teaching license.

$$(\forall x(\text{Teacher}(x) \rightarrow \text{HasLicense}(x)))$$

2. John is a teacher. ( $\text{Teacher}(\text{John})$ )

**Task:** Using **Universal Elimination**, what can you conclude about John?

- a) John has a teaching license.
- b) John does not have a teaching license.
- c) John is not a teacher.
- d) John has a license for driving.

12. Which of the following best describes the outcome of achieving NIL in resolution refutation?

- a) A conclusion that is based on incomplete data
- b) A contradiction that cannot be resolved
- c) A valid conclusion that accurately reflects the original premises
- d) An irrelevant conclusion

13. Which of the following can be inferred directly using forward chaining from the given facts and rules?

**Facts:**

Person (Alice)

Exercises (Alice)

Person (Bob)

**Rules:**

$\text{Person}(x) \wedge \text{Exercises}(x) \rightarrow \text{IsFit}(x)$

$\text{Person}(y) \rightarrow \text{NeedsHydration}(y)$

- a) Alice is not fit.
  - b) Alice is fit.
  - c) Bob is fit.
  - d) Alice needs hydration.
14. Depth First Search is implemented in recursion with \_\_\_\_\_ data structure.
- a) LIFO
  - b) LILO
  - c) FIFO
  - d) FILO
15. Which ones from the list below are the types of Blind Search?
- I.Uniform cost search
  - II.Informed search
  - III.Breadth first search
  - IV.Depth first search
- a) I and II
  - b) III and IV
  - c) I, III and IV
  - d) I, II, III and IV
16. Which search strategy implements queue operation for searching the states?
- a) Depth limited search
  - b) Breadth first search
  - c) Depth first search
  - d) None of above
17. After visiting The National Gallery in London, you suddenly feel hungry. You use the GPS navigation system on your mobile to find the nearby restaurants from your location. Figure 1 is what is shown by the GPS. Here, \_\_\_\_\_ is one of the best algorithms used to search for the neighbouring locations.



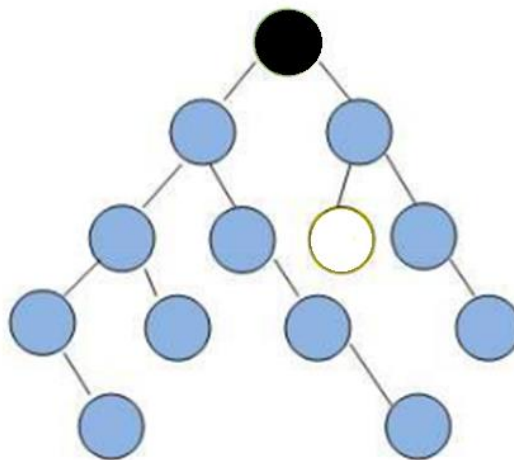
**Figure 1:** Google Maps of London

- a) Breadth-first search
- b) Depth-first search
- c) Uniform cost search
- d) Depth-limited search

18. A route-planning algorithm is designed to find the shortest path from a current location to a destination on a digital map. The algorithm uses the knowledge of the destination to guide the search. Which type of search strategy does this algorithm use?

- a) Data-driven search
- b) Goal-driven search
- c) Random search
- d) Heuristic search

19. Refer to **Figure 2**, assume that if there is ever a choice amongst multiple nodes, both the Breadth First Search (BFS) and Depth First Search (DFS) algorithms will choose the left-most node first.

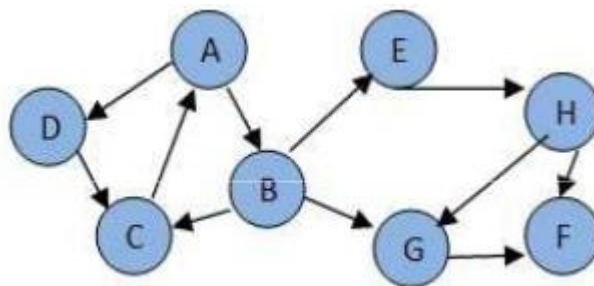


**Figure 2.** Graph with multiple nodes with a path from start black node to goal white node

Starting from the black node at the top, which algorithm will visit the least number of nodes before visiting the white goal node?

- a) DFS
- b) BFS
- c) Neither DFS nor BFS will ever encounter the goal node in this graph
- d) DFS and BFS encounter same number of nodes before encounter the goal node

20. Consider **Figure 3**. If there is ever a decision between multiple neighbour nodes in the BFS or DFS algorithms, assume that the letter closest to the beginning of the alphabet first will be chosen.



**Figure 3.** Graph with multiple neighbour nodes

In what order will the nodes be visited using a BFS and DFS with a path from start node A to goal node F and start node A to goal node D?

- a) ABCDEFGH and HGFEDCAB
- b) ABCDEGHF and ABDEHFGC
- c) ABDCEGHF and ABCEHFGD
- d) ABCDEFGH and ABDEHFGD

## **SECTION B TOTAL: 70 MARKS**

### **Question 1 (6 marks)**

Name which principle of responsible AI relates to this example of application and do provide explanation:

- i. AI chatbots in customer service encrypting user interactions to protect sensitive information like account details.  
Principle:  
Explanation:
- ii. Self-driving car manufacturers held responsible for accidents caused by errors in the AI system, with clear processes to determine fault.  
Principle:  
Explanation:
- iii. Language translation tools, such as Google Translate, supporting regional dialects and less commonly spoken languages.  
Principle:  
Explanation:

### **Question 2 (4 marks)**

Match the Four views (above) with the definitions below, on how it reflects human Intelligence:

- i. \_\_\_\_\_ This view emphasizes making a machine behave in a way indistinguishable from humans
- ii. \_\_\_\_\_ This focuses on understanding how humans think and replicating those thought processes in machines
- iii. \_\_\_\_\_ This involves reasoning and decision-making using logic and formal methods
- iv. \_\_\_\_\_ This focuses on creating agents that act optimally in achieving their goals based on available information

### **Question 3 (6 marks)**

- T: teacher.
- S: student.
- P: studying programming.
- R: reading a book.
- L: likes swimming.
- C: has a cat.



- H: happy.

Convert these **English sentences** into **standard predicate logic** sentences using the provided predicates.

1. There is a teacher who likes swimming.
2. Every student who is studying programming is happy.
3. Some students who are reading a book also like swimming.
4. If a person has a cat, then they are happy.
5. It is not true that all teachers are reading books or studying programming.
6. A person likes swimming if and only if they are studying programming.

#### Question 4 (6 marks)

##### Scenario:

A school has the following policies regarding student participation:

1. **Policy 1:** Any student who participates in both the science club and the math club is eligible for the academic excellence award.
2. **Premise 1:** Emily participates in the science club.
3. **Premise 2:** Emily participates in the math club.

##### Task:

Using **Modus Ponens**, **And Introduction**, and **Universal Elimination**, prove whether Emily is eligible for the academic excellence award. Provide a step-by-step explanation.

#### Question 5 (10 marks)

Given the following statements:

1. All players who practice regularly improve their skills.
2. Anis is a player who practices regularly.
3. If a player improves their skills, they will win matches.

**Prove that Anis will win matches using resolution and refutation.**

Let's denote:

- ( S(x) ): ( x ) practices regularly.
- ( P(x) ): ( x ) improves their skills.
- ( G(x) ): ( x ) wins matches.
- ( A ): Anis

#### Question 6 (15 marks)

The Travelling Salesman Problem (TSP) is a well-known combinatorial optimization problem. A salesman must visit a set of cities exactly once and return to the starting city while minimizing the

total distance travelled. In this question, you are required to solve the TSP using the **backtracking algorithm**.

- Explain the backtracking approach for solving the Travelling Salesman Problem. How does it work and why is it an appropriate method for solving TSP? (5 marks)
- Given the following distance matrix representing the distances between four cities (A, B, C, D) in **Table 1**, draw a graph represents the cities (A, B, C, D) as nodes and the distances between them as edges. (5 marks)

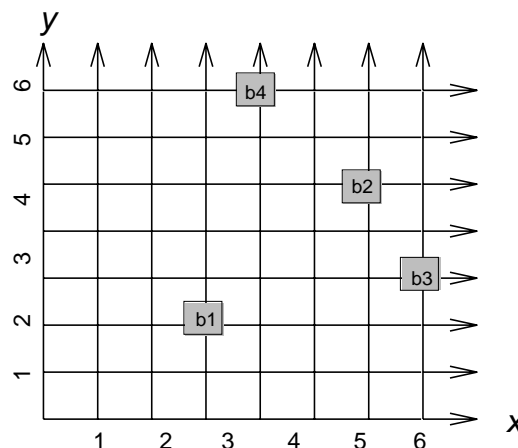
**Table 1.** Distances between four cities (A, B, C, D)

City	A	B	C	D
A	0	10	15	20
B	10	0	35	25
C	15	35	0	30
D	20	25	30	0

- Apply the backtracking algorithm and perform a backtracking search to calculate the optimal tour and its total distance, starting from city A. (5 marks)

### Question 7 (12 marks)

Consider a robot in a world with a group of labeled boxes. These boxes can be placed on any square of an infinite grid, but only one box can occupy a square at a time. The robot can move a box one square in any direction—north(N), south(S), east(E), or west(W)—during each step.



A state in the state space can be described by giving the (x, y) position of each box (assume four boxes):

state(b1(3,2), b2(6,5), b3(7,3), b4(4,7))

The possible actions could be specified by the box and the direction as shown below:

move(b1,N), move(b1,S), move(b1,E), move(b1,W), move(b2, N), move(b2, S), etc
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The robot was given initial and final states as follows:

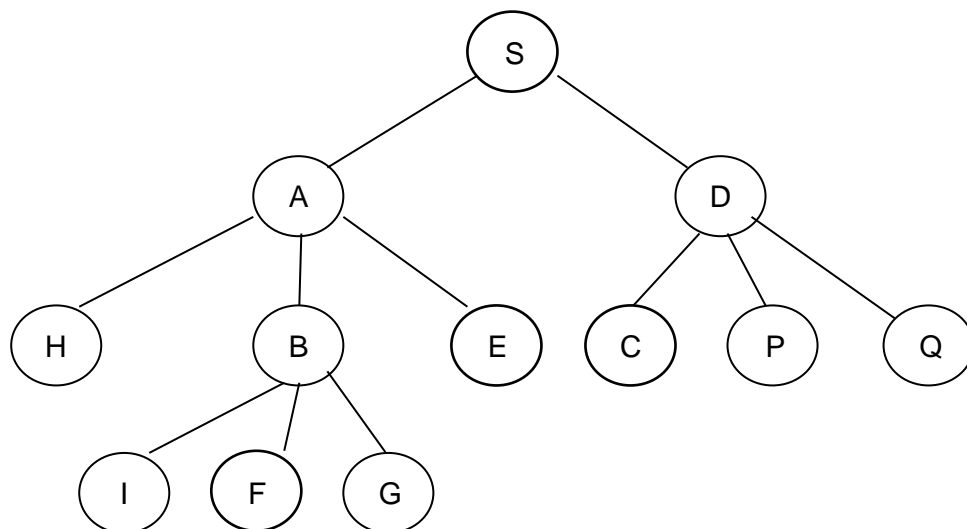
initial:	state(b1(3,2), b2(6,5), b3(7,3), b4(4,7))
final:	state(b1(13,2), b2(6,15), b3(7,1), b4(1,1))

Therefore, the robot could search for a sequence of moves to get from the initial state to the final state.

- Determine the first three states that the robot might consider if it used **Depth first search**. Explain the possible action the robot would attempt moves in the order they are defined in the problem. (4.5marks)
- Determine the first three states that the robot might consider if it used **Breadth first search**. Explain the possible action the robot would attempt moves in the order they are defined in the problem. (4.5marks)
- Which search strategy (depth first or breadth first search) is more practical and effective choice for the robot in this scenario. Explain them. (3marks)

### Question 8 (11 Marks)

Based on the given tree graph in **Figure 1** below, answer all the following questions.



**Figure 1.** Tree graph

- a) Perform a breadth first search on the tree graph above. List down the order of nodes visited assuming the starting node is **S** and the goal node is **C**. (2marks)
- b) Perform a depth first search on the tree graph above. List down the order of nodes visited assuming the starting node is **S** and the goal node is **C**. (2marks)
- c) Determine which search algorithm visits more nodes and by how much. (2marks)
- d) Determine which search algorithm gives the most optimal solution if the objective to traverse the tree is to find the shortest path from S to C. Justify your answer. (2marks)
- e) Assume node S is you on Instagram and the rest of the nodes are friends that you are connected to. Explain how breadth first search algorithm finds close friends in a social network like Instagram. (3marks)