

**INTRODUCTION TO ARTIFICIAL INTELLIGENCE  
(CSEN 3104)**

Time Allotted : 2½ hrs

Full Marks : 60

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A**

1. Answer any twelve:

12 × 1 = 12

*Choose the correct alternative for the following*

- (i) Which of the following is an example of informed search strategy?  
(a) A\* (b) Iterative Deepening (c) DFS (d) UCS.
- (ii) A Bayesian network is  
(a) an undirected graph (b) tree (c) DAG (d) all of these.
- (iii) A state space can be described as  
(a) representation of your problem with variables and parameters  
(b) formulation of your design  
(c) definition to a problem  
(d) the whole problem.
- (iv) For an English sentence, “People only try to assassinate rulers they are not loyal to”, which of the following correctly represent the FOPL form?  
(a)  $\forall x: \forall y: \neg \text{loyalto}(x, y) \rightarrow \text{Person}(x) \wedge \text{Ruler}(y) \wedge \text{tryassassinate}(x, y)$   
(b)  $\forall x: \exists y: \text{Person}(x) \wedge \text{Ruler}(y) \wedge \text{tryassassinate}(x, y) \rightarrow \neg \text{loyalto}(x, y)$   
(c)  $\forall x: \forall y: \text{Person}(x) \wedge \text{Ruler}(y) \wedge \text{tryassassinate}(x, y) \rightarrow \neg \text{loyalto}(x, y)$   
(d) None of these.
- (v) A technique that was developed to determine whether a machine could or could not demonstrate the artificial intelligence known as the \_\_\_\_\_  
(a) Boolean algebra (b) Turing test (c) Propositional logic (d) Algorithm
- (vi) If there are a limited number of distinct, clearly defined percepts and actions, then the environment will be –  
(a) continuous (b) discrete (c) deterministic (d) none of these
- (vii) The environment of the game ‘chess’ is an example of  
(a) accessible, deterministic, static and discrete (b) accessible, non-deterministic, static and continuous  
(c) inaccessible, deterministic, static and discrete (d) none of these.
- (viii) Which of the following search methods can be viewed as a special case of Uniform-cost Search?  
(a) DFS (b) BFS (c) Iterative Deeping (d) A\*.
- (ix) Which value is assigned to alpha and beta in the alpha-beta pruning?  
(a) Alpha = max (b) Beta = min  
(c) Beta = max (d) Both Alpha = max & Beta = min.
- (x) Consider an English sentence given as: “All Romans were either loyal to Caesar or hated him”. Which of the following is the correct FOPL form of the given sentence?  
(a)  $\forall x: \text{loyalto}(x, \text{Caesar}) \vee \text{hated}(x, \text{Caesar}) \rightarrow \text{Roman}(x)$   
(b)  $\forall x: \text{Roman}(x) \rightarrow \text{loyalto}(x, \text{Caesar}) \vee \text{hated}(x, \text{Caesar})$   
(c)  $\exists x: \text{Roman}(x) \rightarrow \text{loyalto}(x, \text{Caesar}) \vee \text{hated}(x, \text{Caesar})$   
(d) None of these.

*Fill in the blanks with the correct word*

- (xi) A Perceptron is a \_\_\_\_\_.
- (xii) If  $h=0$  for all nodes then A\* reduces to \_\_\_\_\_.
- (xiii) An AI agent perceives and acts upon the environment using \_\_\_\_\_.
- (xiv) The search algorithm which is similar to the minimax search, but removes the branches that don't affect the final output is known as \_\_\_\_\_.
- (xv) The true-positive rate is also referred to as \_\_\_\_\_.

## Group - B

2. (a) Consider the following set of propositional statements:

- (1) sunny  $\wedge$  warm  $\rightarrow$  enjoy
- (2) warm  $\wedge$  pleasant  $\rightarrow$  strawberry\_picking
- (3) raining  $\rightarrow \sim$ strawberry\_picking
- (4) raining  $\rightarrow$  wet
- (5) warm
- (6) raining
- (7) sunny

Now, prove by refutation on propositions that "You will enjoy."

[[CSEN3104.2](Analyse/IOCQ)]

(b) A farmer is on the left bank of a river with a boat, a cabbage, a goat, and a wolf. The goal is to get everything to the right bank of the river by maintaining the following restrictions,

- (i) only the farmer can handle the boat
- (ii) when he is in the boat, there is only space for one more item
- (iii) the farmer can't leave the goat alone with the wolf, nor with the cabbage (or something will be eaten)

Formulate the above problem as state-space search problem by clearly representing the initial state, set of goal states and possible operators.

[[CSEN3104.1](Understand/LOCQ)]

(c) Briefly explain different types of agents. Give examples of each.

[[CSEN3104.1](Remember/LOCQ)]

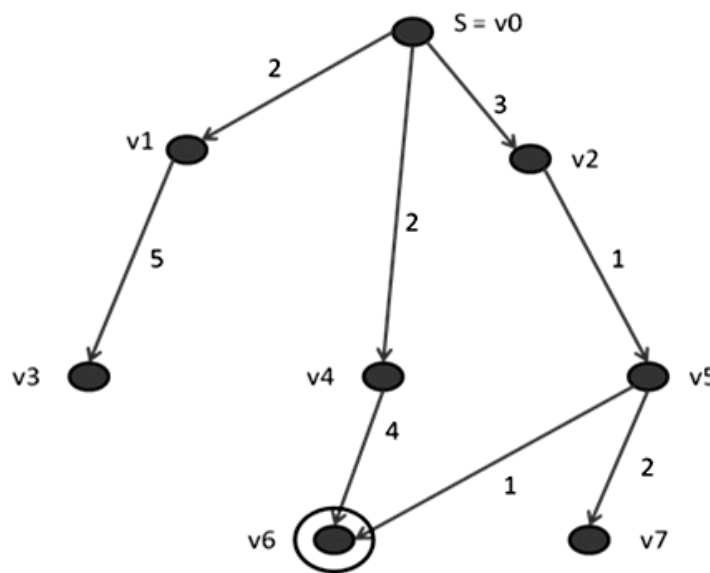
**6 + 3 + 3 = 12**

3. (a) Fill-up the following table – Here b is the maximum branching factor of the search tree, d is the depth of the least cost solution node and m is the maximum depth of state space. Assume that b and d are finite, whereas m can be finite or infinite. If you need a depth-limit, then assume that it is l. A few have been filled up for you.

Search Techniques	Completeness (Yes/No)	Time Complexity (Using Asymptotic notation in b, d, m, l)	Space Complexity (Using Asymptotic notation in b, d, m, l)	Optimality (Yes/No)
Breadth-first search		$O(b^d)$		
Uniform-cost search				Yes
Depth-first search				
Depth-limited search (depth-limit is l)				

[[CSEN3104.1](Remember/LOCQ)]

(b)



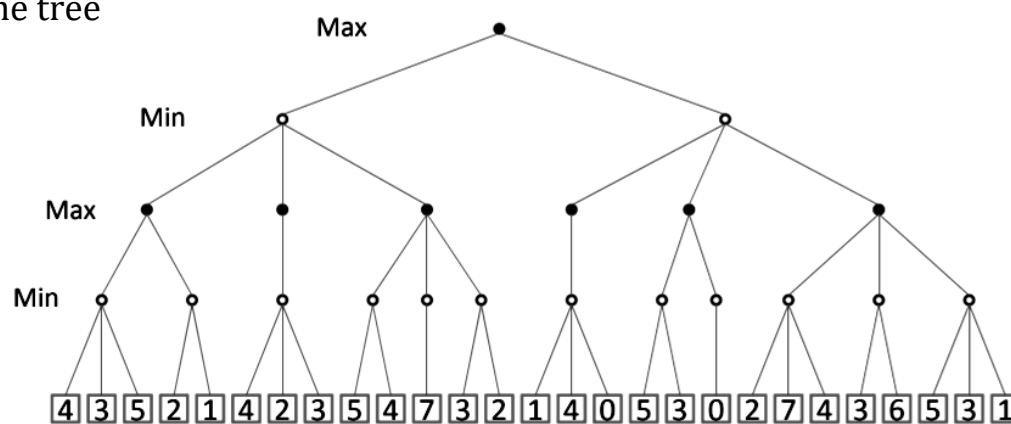
Consider the above graph. The source node is s and the only goal node is marked with a circle. Perform a uniform cost search on this graph to find the optimal path to the goal node. Show the steps by mentioning the g( ) values of the vertices and show the status of the lists that should be maintained (eg. OPEN and CLOSED) at each step.

[[CSEN3104.4](Apply/IOCQ)]

**6 + 6 = 12**

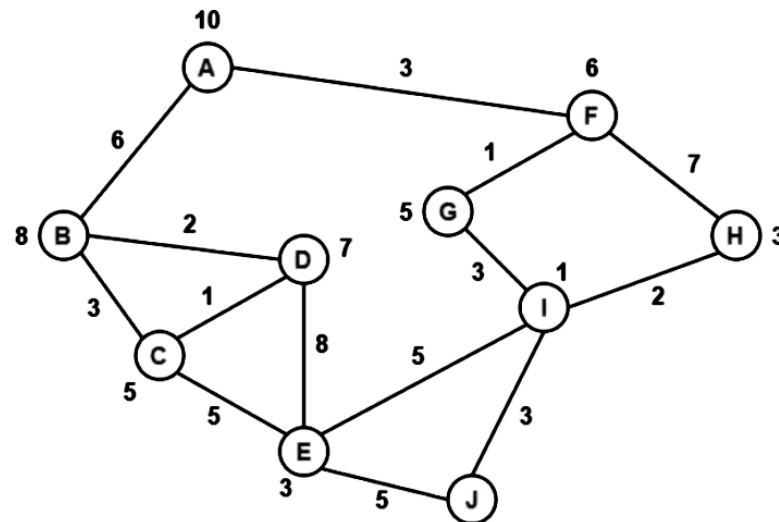
## Group - C

4. (a) Consider the following game tree



- (i) Use MINIMAX algorithm to determine the first player's best move
- (ii) Which nodes would not need to be examined using  $\alpha - \beta$  cutoff algorithm along with the type of cutoff –assuming that nodes are examined in left-to-right order? [[CSEN3104.1](Understand/IOCQ)]
- (b) What is the major issue with Depth First Search problem? How do you tackle this issue? What will be the change in time complexity after updating DFS algorithm? [[CSEN3104.1](Remember/LOCQ)]
- (c) Prove that the heuristic 'sum of manhattan distances' for the 8-puzzle problem is an admissible heuristic. [[CSEN3104.3](Analyze/LOCQ)]  
 **$(2 + 3) + (2 + 2) + 3 = 12$**

5. (a) Consider the following graph

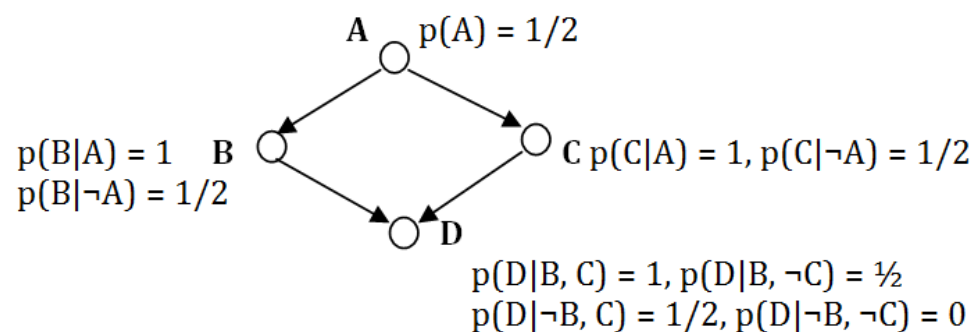


The numbers written on edges represent the distance between the nodes. The numbers written on nodes represent the heuristic value. Find the most cost-effective path to reach from start state A to final state J using A\* Algorithm. [[CSEN3104.4](Remember/IOCQ)]

- (b) What is the drawback of Hill Climbing algorithm and briefly explain what will be your approach to overcome the drawback? [[CSEN3104.1](Analyze/LOCQ)]
- (c) If h is consistent, then prove that  $h(n) \leq c(n, n') + h(n')$  is applicable for any descendant  $n'$  of  $n$ . [[CSEN3104.4](Understand/LOCQ)]  
 **$(2 + 3) + (2 + 2) + 3 = 12$**

### Group - D

6. (a) An admission committee for a college is trying to determine the probability that an admitted candidate is really qualified. The relevant probabilities are given in the following Bayesian network. Find  $p(A|D)$ .



- (b) Write a Prolog program to delete an element from the kth position of the element from a list of N elements. [[CSEN3104.3](Analyze/IOCQ)]
- (c) What are the different approaches to knowledge representation? [[CSEN3104.5](Apply/LOCQ)]  
[[CSEN3104.2](Remember/LOCQ)]  
 **$6 + 3 + 3 = 12$**

7. (a) Consider the following sentences:  
 (i) Anyone passing history exam and winning the lottery is happy.  
 (ii) Anyone who studies or is lucky can pass all the exams.  
 (iii) John did not study but he is lucky.  
 (iv) Anyone who is lucky wins lottery

Answer the following questions:

- (i) Translate the given sentences to their equivalent FOPL form
- (ii) Apply Resolution method to prove that "John is happy". [[CSEN3104.2](Analyze/IOCQ)]
- (b) Write a prolog program to find the product of all the negative numbers present in a list. [[CSEN3104.5](Understand/LOCQ)]  
 **$(3 + 6) + 3 = 12$**

### Group - E

8. (a) Two paediatricians want to investigate a new laboratory test that investigates streptococcal infections. Dr. Kidd uses the standard culture test, which has a sensitivity of 90% and a specificity of 96%. Dr. Childs uses the new test, which is 96% sensitive and 96% specific. After performing several test trails what is your opinion on the following statements " Dr. Kidd will correctly identify more people with streptococcal infection than Dr. Childs" or "Dr. Kidd will correctly identify fewer people with streptococcal infection than Dr. Childs". Justify your answer. [[CSEN3104.6](Evaluate/HOCQ)]

- (b) Differentiate between supervised and unsupervised learning methods. Explain with suitable example. [[CSEN3104.2](Understand/LOCQ)]
- (c) What are the three main components of the expert system? Give a brief statement for each of the components. [[CSEN3104.3](Apply/IOCQ)]
- 6 + 3 + 3 = 12**

9. (a) We are given the following corpus:

<s> I am Sam </s>  
 <s> Sam I am </s>  
 <s> I am Sam </s>  
 <s> I do not like green eggs and Sam </s>

Using a bigram language model with add-one smoothing (if needed), what is Prob.(Sam | am)?

[[CSEN3104.6](Analyse/LOCQ)]

(b) Given the training data in the table below that contains information to classify mammals and non-mammals.

Name	Give Birth	Can Fly	Live in Water	Have Legs	Class
human	yes	no	no	yes	mammals
python	no	no	no	no	non-mammals
salmon	no	no	yes	no	non-mammals
whale	yes	no	yes	no	mammals
frog	no	no	sometimes	yes	non-mammals
komodo	no	no	no	yes	non-mammals
bat	yes	yes	no	yes	mammals
pigeon	no	yes	no	yes	non-mammals
cat	yes	no	no	yes	mammals
leopard shark	yes	no	yes	no	non-mammals
turtle	no	no	sometimes	yes	non-mammals
penguin	no	no	sometimes	yes	non-mammals
porcupine	yes	no	no	yes	mammals
eel	no	no	yes	no	non-mammals
salamander	no	no	sometimes	yes	non-mammals
gila monster	no	no	no	yes	non-mammals
platypus	no	no	no	yes	mammals
owl	no	yes	no	yes	non-mammals
dolphin	yes	no	yes	no	mammals
eagle	no	yes	no	yes	non-mammals

Predict the class of the following new example using Naïve Bayes classification to classify the data from the given information: Give Birth – yes, Can fly – no, Live in Water – yes, Have Legs – no.

[[CSEN3104.6](Evaluate/HOCQ)]

**3 + 9 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	42.74	41.63	15.63

**Course Outcome (CO):**

After the completion of the course students will be able to

- CSEN3104.1. Remember and understand the basic principles of state-space representation of any given problem, various searching and learning algorithms, game playing techniques, logic theorem proving etc.
- CSEN3104.2. Comprehend the importance of knowledge as far as intelligence is concerned and the fundamentals of knowledge representation and inference techniques.
- CSEN3104.3. Apply this knowledge so that it can be used to infer new knowledge in both certain and uncertain environment
- CSEN3104.4. Apply various AI searching algorithms, like state-space search algorithm, adversarial search algorithm, constraint satisfaction search algorithm as and when required.
- CSEN3104.5. Understand the working knowledge of Prolog/ Lisp in order to write simple Prolog/ Lisp programs and explore more sophisticated Prolog/ Lisp code on their own.
- CSEN3104.6. Design and evaluate the performance of a heuristic applied to a real-world situation.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.