ARTIFICIAL INTELLIGENCE
(CSEN 3141)

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 methods is effective for escaping from local minima?
(a) Hill-climbing search algorithm (b) Simulated Annealing
(c) Eliminating heuristic estimate (d) None of these.

(ii) Which of the following is an example of perfect information deterministic game?
(a) Backgammon (b) Tic-Tac-Toe
(c) Poker (d) None 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) A heuristic x is said to dominate y, if at any node n
(a) $x(n) > y(n)$ (b) $x(n) < y(n)$
(c) $x(n) \geq y(n)$ (d) $x(n) \leq y(n)$.

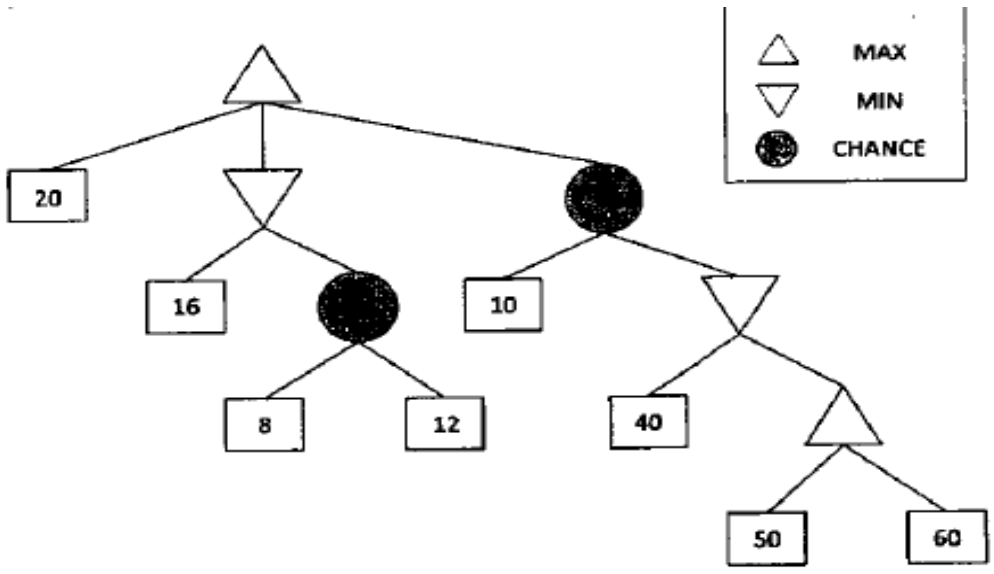
(v) A* finds an optimal solution path in a tree if the heuristic estimates are
(a) Admissible (b) Consistent
(c) All of these (d) None of these.

(vi) 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.

(vii) Which of the following is a valid constraint for a 4-queen problem on a 4x4 chess board, where Q_i stands for the column number of the queen positioned in the ith row.
(a) $|Q_3 - Q_4| \neq 2$ (b) $Q_1 - Q_4 \neq -1$ (c) $|Q_1 - Q_3| \neq 3$ (d) $Q_2 - Q_4 \neq -2$

(viii) 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.

(ix) Consider the following game tree which contains MAX nodes, MIN nodes and chance nodes:



What is the propagated value at the root node if MINIMAX algorithm is applied on the above game tree, assuming each outcome of the chance nodes is equally likely?
(a) 25 (b) 10 (c) 20 (d) None of these.

(x) Consider the following confusion matrix:

		Predicted Class	
		Class = Yes	Class = No
Actual Class	Class = Yes	90	210
	Class = No	140	9560

Which of the following represents the sensitivity of the said classifier?
(a) 98.56% (b) 96.5% (c) 30% (d) None of these.

Fill in the blanks with the correct word

(xi) General algorithm applied on game tree for making decision of win/lose is _____ algorithm.

(xii) At MAX nodes of a game tree, the best backed – up values found so far is called _____.

(xiii) In a decision tree, a homogeneous split should have _____ degree of impurity.

(xiv) ID3 uses _____ as its attribute selection measure.

(xv) Chaining is a special case of _____.

Group - B

2. (a) Consider the Missionaries and Cannibals problem described below:
Three missionaries and three cannibals come to a river. There is a boat on their side of the river that can be used by either one/ two persons. How should they use this boat to cross the river in such a way that the cannibals never outnumbered missionaries on either side of the river?

(b) Now, answer the following questions:
(i) Specify the state description of the problem by clearly mentioning start state, goal state and the possible operators.
(ii) Show at least one solution of the problem by using the state descriptions and the operators mentioned in part (i).

[(CSEN3141.4)(Apply/IOCQ)]

(2 + 2 + 2) + (3 + 3) = 12

3. (a) Consider the following set of English sentences:
1. The-humidity-is-high or the-sky-is-cloudy.
2. If the-sky-is-cloudy then it-will-rain
3. If the-humidity-is-high then it-is-hot.
4. it-is-not-hot

Now, Prove by resolution theorem on propositions that "it-will-rain". *[(CSEN3141.3)(Analyze/IOCQ)]*

(b) 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 are done for you.

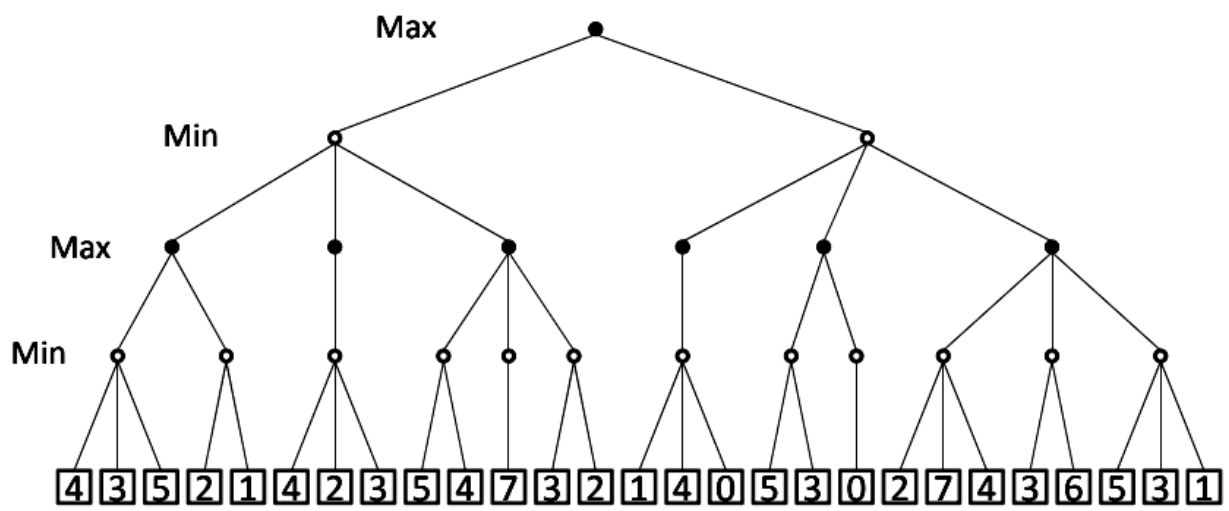
Search Techniques	Completeness (Yes/No)	Time Complexity (Using Asymptotic notation in b, d, m, l)	Space Complexity (Using Asymptotic notation in b, d, m, l)	Optimality (Yes/No)
Breadth-first search		$O(b^d)$		
Uniform-cost search				Yes
Depth-first search				
Depth-limited search (depth-limit is l)				

[(CSEN3141.1)(Remember/LOCQ)]

5 + 7 = 12

Group - C

04. (a) Consider the following game tree.



(i) Use the MINIMAX algorithm to determine the first player's best move

(ii) What nodes would not need to be examined using α – β cutoff algorithm along with the type of cutoff –assuming that nodes are examined in left-to-right order? *[(CSEN3141.1)(Understand/IOCQ)]*

(b) What is the drawback of Hill Climbing algorithm and briefly explain what will be your approach to overcome the drawback? *[(CSEN3141.2)(Remember/LOCQ)]*

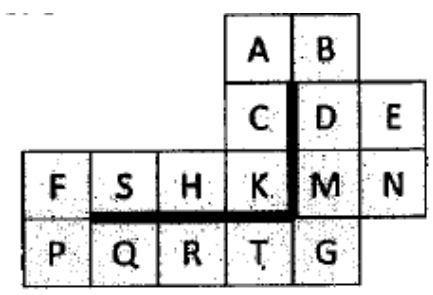
(c) Prove that the heuristic 'sum of manhattan distances' for the 8-puzzle problem is an admissible heuristic. *[(CSEN3141.1)(Understand/LOCQ)]*

(2 + 3) + (2 + 2) + 3 = 12

5. (a) When do you call a heuristic to be admissible and when do you call it consistent? *[(CSEN3141.1)(Remember/LOCQ)]*

(b) If a heuristic h is consistent, then prove that $h(n) \leq c(n, n') + h(n')$ is applicable for any descendant n' of n. *[(CSEN3141.4)(Evaluate/HOCQ)]*

(c) Consider the following maze where the successors of a cell include any adjacent cell in the directions North, South, East, and West of the current cell, except at the boundary of the maze, or when a barrier (thick line) exists.

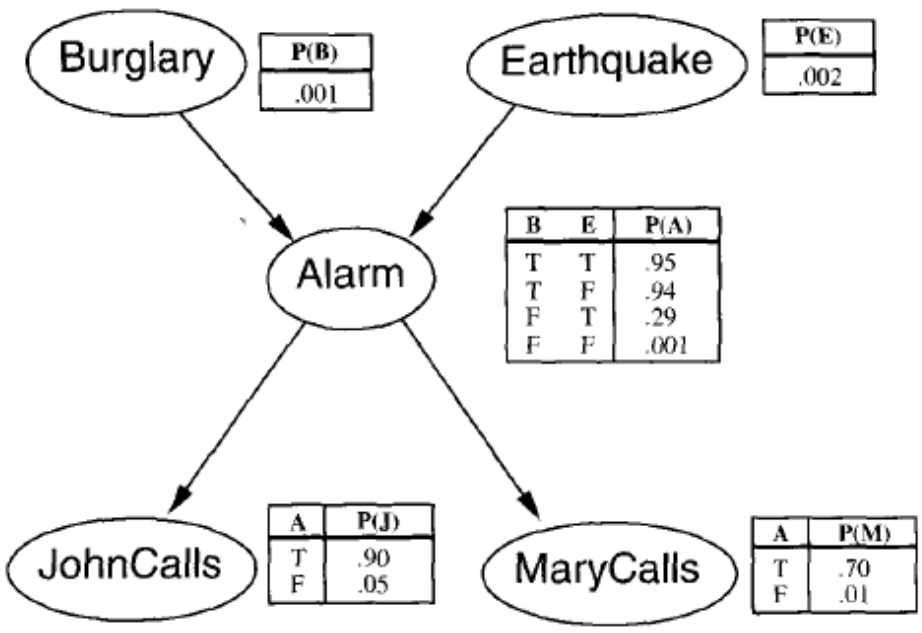


For example, successors (M) = {D, N, G} and successors (K) = {C, H}.
Suppose the source node is S and there are two goal nodes – D and M.
Find the order of the nodes expanded if A* search algorithm is applied on the above maze to find any of the solution paths. Use the function h(X) as the heuristic function for node X, which is defined as the smallest Manhattan Distance from node X to any of the goal nodes assuming there are no barriers. For example, h (K) = 1, h (S) = 3. Assume that each move has cost 1. *[(CSEN3141.6)(Apply/IOCQ)]*

2 + 3 + 7 = 12

Group - D

6. (a) Let's consider the following situation:
You have a new burglar alarm installed at home. It is fairly reliable at detecting a burglary, but also responds on occasion to minor earthquakes. You also have two neighbours, John and Mary, who have promised to call you at work when they hear the alarm. John quite reliably calls when he hears the alarm, but sometimes confuses the telephone ringing with the alarm and calls then too. Mary, on the other hand, likes loud music and misses the alarm altogether sometimes.



Calculate the probability of the event that the alarm has sounded but neither a burglary nor an earthquake has occurred, and both Mary and John calls. *[(CSEN3141.6)(Evaluate/IOCQ)]*

(b) Write a prolog program to count the number of vowels and consonant from a given list of alphabets. *[(CSEN3141.5)(Apply/LOCQ)]*

(c) Consider two fuzzy sets A & B defines as follows:
A = {1/a, 0.3/b, 0.2/c 0.8/d, 0/e}
B = {0.6/a, 0.9/b, 0.1/c, 0.3/d, 0.2/e}
Now, compute the following:
(i) A U B (ii) A ∩ B (iii) support (A) (iv) support (B). *[(CSEN3141.3)(Understand/LOCQ)]*

4 + 4 + 4 = 12

7. (a) Consider the following English sentences:
A. Tom owns a kindle.
B. Every kindle owner loves books.
C. No book lover burns books.
D. Either Tom or Austin burned the book called Origin.
E. Every kindle is a book.
Now, answer the following questions:
(i) Encode each sentence in First Order Predicate Logic (FOPL) form using the following predicates:

owns(x, y): x owns y
bookLover(x): x is a book lover
burns(x, y): x burns y
book(x): x is a book
kindle(x): x is a kindle

(ii) Convert all the FOPL sentences to Conjunctive Normal Form (CNF).

(iii) Apply resolution method on these CNF sentences to answer the query "Did Austin burn the Origin?"

[(CSEN3141.3)(Apply/IOCQ)]

(b) What do you mean by conditional independence? *[(CSEN3141.2)(Remember/LOCQ)]*

(2.5 + 2.5 + 5) + 2 = 12

Group - E

8. (a) Explain briefly why single layer perceptron cannot apply to implement XOR gate. *[(CSEN3141.1)(Remember/LOCQ)]*

(b) Define the terms: Precision, Recall, Specificity. *[(CSEN3141.2) (Remember/LOCQ)]*

(c) Consider the following training dataset:

RID	age	income	student	credit_rating	Class: buys_computer
1	youth	high	no	fair	no
2	youth	high	no	excellent	no
3	middle_aged	high	no	fair	yes
4	senior	medium	no	fair	yes
5	senior	low	yes	fair	yes
6	senior	low	yes	excellent	no
7	middle_aged	low	yes	excellent	yes
8	youth	medium	no	fair	no
9	youth	low	yes	fair	yes
10	senior	medium	yes	fair	yes
11	youth	medium	yes	excellent	yes
12	middle_aged	medium	no	excellent	yes
13	middle_aged	high	yes	fair	yes
14	senior	medium	no	excellent	no

Based on the above training data, classify the following test data x using Naïve Bayes classifier:

x = (age=youth, income=medium, student=yes, credit_rating=fair).

Your answer will tell whether it is more likely to buy a computer or not on the given day mentioned as test data.

[(CSEN3141.6)(Evaluate/IOCQ)]

3 + (1 + 1 + 1) + 6 = 12

9. (a) Differentiate between total – order planning and partial – order planning. *[(CSEN3141.1)(Understand/LOCQ)]*

(b) Write short notes on any ***two*** of the following three topics.

i) Tokenization

ii) POS Tagging

iii) Naïve Bayes Classifier. *[(CSEN3141.1)(Remember,Understand/LOCQ)]*

2 + (5 + 5) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.4	61.5	3

Course Outcome (CO):

After the completion of the course students will be able to

CSEN 3141.1 Remember and understand the basic principles of state-space representation of any given problem, various searching and learning algorithms, game playing techniques, planning algorithms, logic theorem proving, natural language processing etc.

CSEN3141.2 Comprehend the importance of knowledge as far as intelligence is concerned and the fundamentals of knowledge representation and inference techniques.

CSEN3141.3 Use the knowledge gained so far to logically infer new knowledges in both certain and uncertain environment.

CSEN3141.4 Illustrate various AI searching algorithms, like state-space search algorithm, adversarial search algorithm, constraint satisfaction search algorithm and different learning models and planning techniques as and when required.

CSEN3141.5 Apply the working knowledge of Prolog/ Lisp in order to write simple Prolog/Lisp programs and to explore more sophisticated Prolog/ Lisp code on their own.

CSEN3141.6 Design and evaluate the performance of various heuristics applied to real-world situations.

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