2015

Artificial Intelligence
(CSEN 5235)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following: **10 x 1=10**

(i) If in a problem the number of initial states is much more than the number of final states, then we should use
- (a) backward reasoning (b) forward reasoning
- (c) both (a) & (b) (d) none of these.

(ii) A Bayesian network is a
- (a) tree (b) directed graph
- (c) undirected graph (d) none of these.

(iii) On the optimal path generated by A* algorithm, h-cost (heuristic cost) of the root node =8. At a node N on this path g-cost (generation cost) = 2; its h-cost is
- (a) 6 (b) 8
- (c) 10 (d) 2.

(iv) Skolem function is used in
- (a) unification algorithm (b) natural deduction
- (c) conversion to CNF (d) none of these.

(v) Inheritable knowledge is best represented by
- (a) semantic net (b) database
- (c) FOPL (d) none of these.

(vi) Horn clause is a clause with _____ positive literals
- (a) at most one (b) at most two
- (c) at least one (d) none of these.

(vii) In MINIMAX algorithm search process obeys
- (a) BFS fashion (b) DFS fashion
- (c) both (a) and (b) (d) none of these.

(viii) The time complexity & space complexity for bidirectional BFS technique respectively are (with branching factor b and depth d)

(a) $O(b^d)$, $O(b^d)$ (b) $O(b^{d/2})$, $O(b^{d/2})$

(c) $O(b^{d/2})$, $O(b^d)$ (d) $O(b^d)$, $O(b^{d/2})$.

(ix) For a given proposition p, $p \vee \neg p$ = true is a

(a) satisfiable formula (b) tautology

(c) both (a) & (b) (d) None of these.

(x) What will be the output of the following prolog program segment?

fib (0,0).

fib (F, G):- Y is F – 1, fib(Y, U), G is F + U. For ? fib (3, X).

(a) X = 0 1 1 (b) X = 1 1 2

(c) X = 2 (d) none of these.

Group – B

2.(a) Given a full 5-gallon jug and an empty 2-gallon jug, the goal is to fill the 2-gallon jug with exactly one gallon of water. Formulate this problem as a state space search problem. Show at least one solution path of the above problem.

(b) Suppose you have the following search space:

State	next	cost
A	B	4
A	C	1
B	D	3
B	E	8
C	C	0
C	D	2
C	F	6
D	C	2
D	E	4
E	G	2
F	G	8

i. Draw the state space of this problem

ii. If the initial state is **A** and the goal state is **G,** the show how DFS & Iterative Deepening DFS search strategies would create a search tree to find a path from the initial state to the goal state. At each step of the search algorithm, show which node is being expanded, and also report the eventual solution found by each algorithm, and the solution cost.

(2+2)+(2+6)=12

3.(a) Define admissible & consistent heuristic. For a heuristic h, prove the following:

i) if A* uses a consistent heuristic, then f(n) is non-decreasing along any path.

ii) if h is consistent, then prove that h is admissible also.

(b) Prove that the heuristic 'Sum of Manhattan distances' for the 8-puzzle problem is an admissible heuristic.

(1+(2+2))+7=12

Group – C

4.(a) Define α – cutoff & β – cutoff of a game tree.

(b) Consider the game of tic-tac-toe. Assume that X is the MAX player and O is the MIN player. Given the game board **board2** below where it is X's turn to play next, show the game tree with a cut-off depth of two ply (i.e., stop after each player makes one move). Use the following evaluation function on all leaf nodes:

Eval(s) = 10X3(s) + 3X2(s) + X1(s) – (10O3(s) +3O2(s) + O1(s)), where we define Xn(*s*) as the number of rows, columns, or diagonals in state *s* with exactly *n* X's and no O's, and similarly define On(*s*) as the number of rows, columns, or diagonals in state *s* with exactly *n* O's and no X's.

i. Use the MINIMAX algorithm to determine X's best move.
ii. What nodes would not need to be examined using α – β cutoff algorithm – assuming that nodes are examined in left-to-right order?

board2

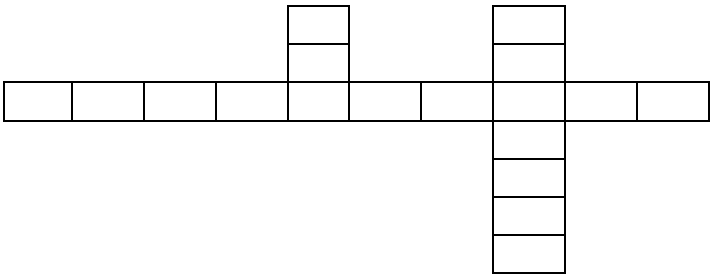
	X	
O		
X		O

2+(5+5)=12

5.(a) Define Constraint Satisfaction Problem (CSP).

(b) Consider a variant of the crossword puzzle problem. In this variant, we assume that we have a set of words W_1, W_2, ..., W_n and a crossword puzzle grid. Our goal is to fill the crossword grid with the words such that letters of intersecting words match. An empty crossword grid and the words are given below:

Words are: THE, UNIVERSITY, OF, CHICAGO



i. Formulate this problem as a CSP.
ii. Show how backtracking method can be used to find a solution of the given problem

2+(5+5)=12

Group – D

6.(a) What are the different approaches to knowledge representation?

(b) Consider the following English sentences:

i. Everyone who loves all animals is loved by someone
ii. Anyone who kills an animal is loved by no one
iii. Jack loves all animals
iv. Either Jack or Curiosity killed the cat, who is named as Tuna

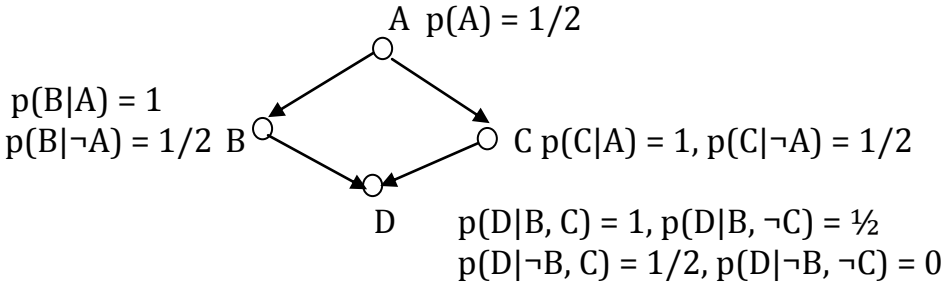
Now from these given sentences, prove that 'Did Curiosity kill the cat?' using resolution method.

3+9=12

7.(a) The relation **balanced (L)** takes a list of characters as argument. Each character in L is either an open parenthesis '('or a closed parenthesis')'. Write a prolog program to determine whether L when viewed as a sequence of parenthesis is well-formed in the normal algebraic sense.

(b) Consider the following two sentences:
Every truck is a vehicle. Every trailer truck is a truck that has as part a trailer, an unloaded weight, which is a weight measure, a maximum gross weight, which is a weight measure, a cargo capacity, which is a volume measure, and a number of wheels, which is the integer 18.
Provide Semantic Net representation of the above sentences and then show how inference can be done using this network structure.

(c) 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).



Group – E

8.(a) Consider the following initial & the goal state for the Block's world problem. Construct a set of operators (rules) and hence generate a plan to reach the goal state from the initial state using Goal-Stack planning method

Initial State: On (C, A), Clear (C), On (B, Table), Clear (B)
Goal State: On (B, A), On (C, B)

(b) Explain the operation of an expert system by discussing expert system shell.

8+4=12

9.(a) What do you mean by over-fitting in Decision Trees? Describe briefly how Reduced Error pruning can be used to remove over-fitting from a decision tree.

(b) Create a decision tree by using the given dataset that describes what a set of people might decide to do on weekend based on a set of attributes that characterizes the weekends. Here, the weekends are described by the attributes Weather, Parents and Financial condition. Use entropy as the impurity measure while creating the Decision Tree.

Weekend	Weather	Parents	Financial Condition	Decision
W1	Sunny	Yes	Rich	Cinema
W2	Sunny	No	Rich	Play Tennis
W3	Windy	Yes	Rich	Cinema
W4	Rainy	Yes	Poor	Cinema
W5	Rainy	No	Poor	Stay in
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Play Tennis

(1+2)+9=12