(b) Construct (induct) a decision tree using information gain from the data provided in the following table. Consider the Gender as the class label

Sl. No.	Over 170CM	Eye	Hair length	Gender
1	No	Blue	Short	Male
2	Yes	Brown	Long	Female
3	No	Blue	Long	Female
4	No	Blue	Long	Female
5	Yes	Brown	Short	Male
6	No	Blue	Long	Female
7	Yes	Brown	Short	Female
8	Yes	Blue	Long	Male

3 + 9 = 12

ARTIFICIAL INTELLIGENCE
(CSEN 3281)

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 alternative for the following: **10 × 1 = 10**

(i) Inheritable knowledge is best represented by
(a) Semantic net (b) database
(c) FOPL (d) none of these.

(ii) Which is not a property of representation of knowledge?
(a) Representational Verification (b) Representational Adequacy
(c) Inferential Adequacy (d) Inferential Efficiency.

(iii) An 'agent' is anything that
(a) Perceives its environment through sensors and acting upon that environment through actuators
(b) Takes input from the surroundings and uses its intelligence and performs the desired operations
(c) A embedded program controlling line following robot
(d) All of the mentioned.

(iv) Which method is effective for escaping from local minima?
(a) Updating heuristic estimate (b) Reducing heuristic estimate
(c) Eliminating heuristic estimate (d) None of the mentioned.

(v) Which function is used to calculate the feasibility of whole game tree?
(a) Alpha-beta pruning (b) Transposition
(c) Evaluation function (d) All of the mentioned.

(vi) A Perceptron is a _____.
(a) feed-forward neural network (b) back-propagation algorithm
(c) back-tracking algorithm (d) feed forward-backward algorithm.

(vii) In Baye's theorem, what is the meant by p(Hi|E)?
(a) The probability that hypotheses Hi is true given evidence E
(b) The probability that hypotheses Hi is false given evidence E
(c) The probability that hypotheses Hi is true given false evidence E
(d) The probability that hypotheses Hi is false given false evidence E.

(viii) Which is used to compute the truth of any sentence?
(a) First-order logic
(b) Semantics of propositional logic
(c) Alpha-beta pruning
(d) Both (a) & (b).

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

(x) To which depth does the alpha-beta pruning can be applied?
(a) 10 states (b) 8 States
(c) 6 States (d) Any depth.

Group – B

2. (a) Determine whether each of the following sentence is satisfiable, contradictory or valid, where P, Q & R are propositions:
(i) $(P \& Q) \vee \neg (P \& Q)$
(ii) $(P \vee Q) \rightarrow (P \& Q)$
(iii) $(P \& Q) \rightarrow R \vee \neg Q$
(iv) $(P \vee Q) \& (P \vee \neg Q) \vee P$.

(b) In the water-jug puzzle, we are given a 3-litre jug, named Three, and a 4-litre jug, named Four. Initially, both Three & Four are empty. Either jug can be filled with water from a tap, T, and we can discard water from either jug down a drain, D. Water may be poured from one jug into the other. There is no additional measuring device. We want to find a set of operations that will leave precisely two liters of water in Four.
(i) Give the state-space representation of the problem.
(ii) Provide at-least one solution of the given problem.

(c) "Modus ponens is also a special case of resolution" – Justify the statement for propositions with suitable example.

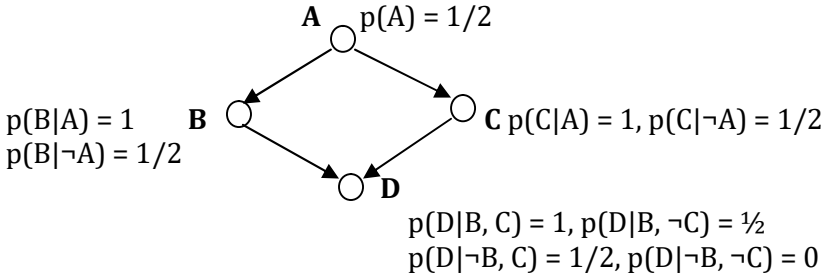
4 + (3 + 2) + 3 = 12

Now answer the following questions:
(i) Convert the above sentences into FOPL form
(ii) Translate the above FOPL sentences into CNF form
(iii) Show by using resolution that the predicate GETTO (Town-D, Town-B) can be deduced from the above clauses.

(b) Write a PROLOG clause for having DOUBLE (L, LL). Every element in list L appears twice in list LL. For example DOUBLE ([1, 2, 3], [1, 1, 2, 2, 3, 3]).

(2 + 3 + 4) + 3 = 12

7. (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) State the difference between Inheritable knowledge and Inferential knowledge. Construct the semantic net for "Sam gave the flower buckeyes to Manu on her birthday".

7 + (2 + 3) = 12

Group – E

8. (a) Explain how Roulette Wheel Selection process can be used in the selection process of the Genetic Algorithm to create new offspring representing the best chromosomes.

(b) Explain how Artificial Neural Network can be used as a classifier.

5 + 7 = 12

9. (a) Define information gain.

3. (a) 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.

(b) Justify each of the following statements:

(i) BFS is a special case of Uniform-Cost search

(ii) DFS can be viewed as a special case of Depth-limited search

(1 + 6) + (2.5 + 2.5) = 12

Group – C

4. (a) Consider the following problem:

The 8 – puzzle consists of a 3 × 3 board with 8 numbered tiles & a blank space. Each tile has a number on it. A tile adjacent to the blank space can only slide into that space. The game consists of a starting position & a specified goal position. The goal is to transform the starting position into the goal position by sliding the tiles around.

Now, considering the following start & goal configurations, apply A* algorithm to find the solution path from start state to goal state, where 'Sum of Manhattan distances' is used as a heuristic function. You may consider g(n) = the depth of node n in the search tree.

Start

2	8	3
1	6	4
7		5

Goal

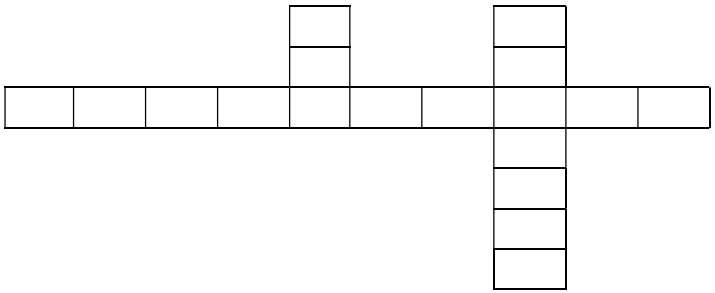
1	2	3
8		4
7	6	5

(b) 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

7 + (2.5 + 2.5) = 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) Given the following facts & rules as a knowledge base:
A1. Town-A is connected to Town-B by Road-1.
A2. Town-B is connected to Town-C by Road-2.
A3. Town-A is connected to Town-C by Road-3.
A4. Town-D is connected to Town-E by Road-4.
A5. Town-D is connected to Town-B by Road-5.
A6. Bikes are allowed on Road-3, Road-4, and Road-5.
A7. Bikes are always allowed on either Road-2 or Road-1.
A8. Town-A and Town-E are not connected by Road-3.
A9. If town x is connected to town y by highway z, bikes are allowed on z, you can get to y from x by bike.
A10. If town x is connected to y by z, y is connected to x by z.
A11. If you can get to y from x, and you can get to z from y, you can get to z from x.