ARTIFICIAL INTELLIGENCE
(CSBS 3111)

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) What is Artificial intelligence?
(a) Putting your intelligence into Computer (b) Programming with your own intelligence
(c) Making a Machine intelligent (d) Playing a Game

(ii) Inheritable knowledge is best represented by
(a) Semantic net (b) FOPL (c) Frame (d) None of these.

(iii) Which of the following algorithm face the local maximum problem?
(a) Hill Climbing (b) Breadth-first search
(c) Best-first search (d) All of these.

(iv) In a decision tree, what is represented through an internal node?
(a) Decision (b) Test (c) Result (d) Result.

(v) A* algorithm is based on
(a) Breadth-First-Search (b) Depth-First –Search
(c) Best-First-Search (d) Hill climbing.

(vi) According to binary resolution if ¬P(x, a) ∨ Q(x) and ¬Q(b) ∨ R(x) then the binary resolvent is
(a) ¬P(x, a) ∨ R(x) (b) ¬P(b, a) ∨ R(b) (c) ¬P(b, a) ∨ R(x) (d) None of these.

(vii) Which of the following is a tautology?
(a) p ∨ q → p (b) p ∧ q → p (c) p → q (d) None of these.

(viii) Which of the following is the heuristic search?
(a) Depth-first search (b) Breadth-first search
(c) Best-first search (d) None of these.

(ix) The process of adding new knowledge to a knowledge base and refining or improving the knowledge that was previously stored is called
(a) knowledge acquisition (b) knowledge representation
(c) knowledge inference (d) none of these.

(x) Which one is blind search?
(a) A* (b) Best First (c) DFS (d) AO*.

Group- B

2. We have 3 jugs of capacities 3, 5, and 8 litres, respectively. There is no scale on the jugs, so it's only their capacities that we certainly know. Initially, the 8-litre jug is full of water, the other two are empty. Now answer the following questions:
   (i) Formulate this problem as state-space search problem by clearly representing the initial state, set of goal states and possible operators.
   (ii) Draw the state-space graph for the problem.
   (iii) Show any one solution to the problem by specifying the sequence of operators.

   [(CO1)(Analyze/IOCQ)]

   (4 + 4 + 4) = 12

3. 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

The initial state is A and the goal state is G, showing how DFS and 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, report the eventual solution found by each algorithm, and the solution cost. [(CO2)(Apply/IOCQ)]

(6 + 6) = 12

Group – C

4. (a) What do you mean by Constraint Satisfaction Problem? [(CO3)(Understand/LOCQ)]
   (b) Apply A* algorithm to find out the shortest path from start node a to goal node z for the following graph given in Fig.1: [(CO2)(Apply/IOCQ)]

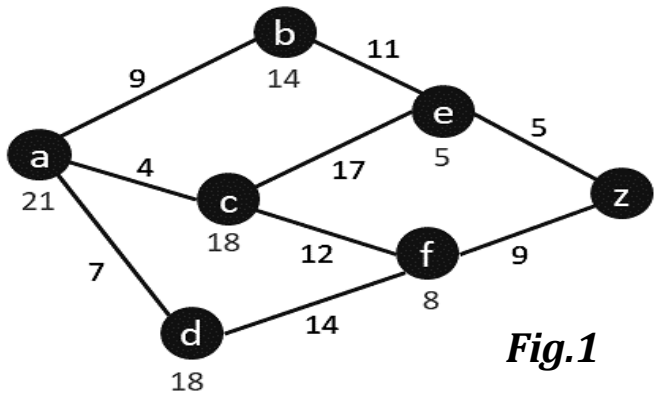
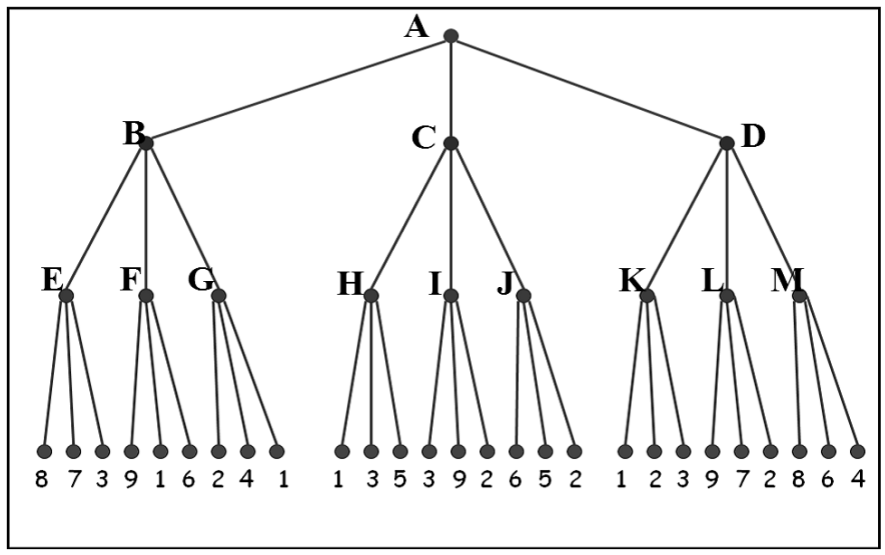


Fig.1

3 + 9 = 12

5. (a) Consider the following 2 player game tree in which static scores are given from the first player's point of view:



Suppose the first player is the maximizing player. What move should be chosen? Why? Use Mini-Max search to solve. Also explain limitations of Mini-Max search. How to overcome them? [(CO3)(Analyze/IOCQ)]

(b) Solve the following Crypt-arithmetic problem with the following constraints. Give solution steps. Constraints: Use decimal arithmetic.

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  C R O S S
+ R O A D S
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D A N G E R
```

[(CO3)(Apply/IOCQ)]

8 + 4 = 12

Group - D

6. (a) Show that the following pair of propositions are logically equivalent.
$(p \rightarrow r) \wedge (q \rightarrow r)$, $((p \vee q) \rightarrow r)$. [(CO4)(Apply/IOCQ)]

(b) Prove that the proposition $(p \leftrightarrow q) \wedge (\neg p \wedge q)$ is a contradiction. [(CO4)(Apply/IOCQ)]

(c) Verify the following theorems by Wang's algorithm.
$p \vee q, p \rightarrow r, q \rightarrow r \Rightarrow r$. [(CO4)(Analyze/IOCQ)]

3 + 3 + 6 = 12

7. (a) Give predicate logic statements to describe the following:
(i) All that glitters is not gold.
(ii) Every boy who loves Mary hates every boy whom Mary loves. [(CO5)(Analyse/IOCQ)]

(b) Consider the following knowledge base:
(i) Every child loves anyone who gives the child a present.
(ii) Every child will be given some presents by Santa if Santa can travel on Christmas Eve.
(iii) It is foggy on Christmas Eve.
(iv) Anytime it is foggy, anyone can travel if he has some source of light.
(v) Any reindeer with a red nose is a source of light.
(vi) (***Conclusion***) If Santa has some reindeer with a red nose, then every child loves Santa.
Prove by the resolution theorem that the **conclusion** is derivable from the knowledge base. [(CO5)(Analyse/IOCQ)]

(2 + 2) + 8 = 12

Group - E

8. (a) Consider you tossing a fair coin three times.
(i) What is the probability of three heads, HHH?

(ii) What is the probability that you observe exactly one head?

(iii) Given that you have observed at least one head, what is the probability that you observe at least two heads? [(CO6) (Analyse/IOCQ)]

(b) Consider a routine screening test for a disease. Suppose the frequency of the disease in the population is 0.5%. The test is highly accurate with a 5% false positive rate and a 10% false negative rate. You take the test and it comes back positive. What is the probability that you have the disease? [(CO6) (Analyse/IOCQ)]

(3 × 2) + 6 = 12

9. Consider the following training dataset:

Outlook	Temperature	Humidity	Wind	Play Tennis
Sunny	Hot	High	Weak	No
Sunny	Hot	High	Strong	No
Overcast	Hot	High	Weak	Yes
Rain	Mild	High	Weak	Yes
Rain	Cool	Normal	Weak	Yes
Rain	Cool	Normal	Strong	No
Overcast	Cool	Normal	Strong	Yes
Sunny	Mild	High	Weak	No
Sunny	Cool	Normal	Weak	Yes
Rain	Mild	Normal	Weak	Yes
Sunny	Mild	Normal	Strong	Yes
Overcast	Mild	High	Strong	Yes
Overcast	Hot	Normal	Weak	Yes
Rain	Mild	High	Strong	No

Apply the Naïve-Bayes classifier on the above training dataset to predict the class label of a test record X = (Outlook = Sunny, Temperature = Hot, Humidity = Normal, Wind = Strong). [(CO6)(Apply/IOCQ)]

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	3.125	96.875	0

Course Outcome (CO):

After the completion of the course, students will be able to

CO1. Apply the basic principles of state space to formulate classical AI problems.

CO2. Demonstrate the uninformed and informed search techniques to solve the searching problems

CO3. Illustrate adversarial searching algorithms and constraint satisfaction problems as and when required.

CO4. Interpret the basic principles of knowledge representation and propositional logic.

CO5. Investigate the knowledge using first-order predicate logic to solve various AI problems based on the human behaviour.

CO6. Construct AI models to solve real world problems using learning techniques and probabilistic models.

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