Name:

Enrolment No:

MANIPAL UNIVERSITY JAIPUR

Even Semester Mid Term Examination, March 2024
Faculty of Engineering, School of Information, Security and Data Science
Department of Information Technology
B Tech – IT

Course Code: IT3201	**Course:** Artificial Intelligence and Machine Learning	**Semester: VI**
Time: 1.5 hrs.		**Max. Marks: 30**

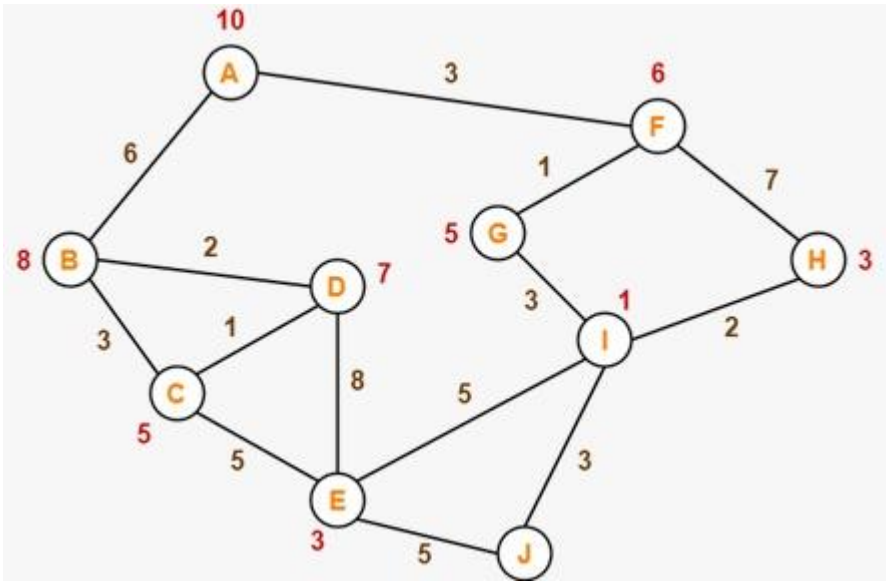
Instructions: All questions are compulsory.
Missing data, if any, may be assumed suitably.
Calculator is allowed.

SOLUTION &Marking Scheme

SECTION A (Memory Based Questions)

<table>
<tr><th>S.No.</th><th></th><th>Marks</th><th>CO</th></tr>
<tr><td>Q 1</td><td>Define water Jug problem as state space representation.
Problem statement, initial state, goal state, few rules (1/2 mark for each)</td><td>2</td><td>IT3201.1</td></tr>
<tr><td>Q 2</td><td>What do you mean by Agent. State the relationship between agent and environment.
An agent is anything that can perceive its environment through sensors and acts upon that environment through effectors/Actuators. Definition 1 mark, relationship with environment 1 mark</td><td>2</td><td>IT3201.2</td></tr>
<tr><td>Q 3</td><td>State and differentiate informed and uninformed searches with the help of suitable examples.
<table>
<tr><th>Parameters</th><th>Informed Search</th><th>Uninformed Search</th></tr>
<tr><td>Knowledge Utilization</td><td>It applies knowledge during the search process.</td><td>It does not use any knowledge during search process.</td></tr>
<tr><td>Speed</td><td>It finds solutions faster.</td><td>It finds solutions at a slower pace.</td></tr>
<tr><td>Completion</td><td>It can be both complete and incomplete.</td><td>It is always complete.</td></tr>
<tr><td>Time Consumption</td><td>It consumes less time due to faster searches.</td><td>It takes more time due to slower sear</td></tr>
<tr><td>Cost Incurred</td><td>It incurs lower costs.</td><td>It incurs higher costs.</td></tr>
<tr><td>Guidance</td><td>The AI receives suggestions on how and where to find solutions.</td><td>The AI does not receive any suggesti finding solutions. It relies on the infor provided.</td></tr>
<tr><td>Efficiency</td><td>It is more efficient due to lower costs and faster results.</td><td>It is less efficient due to higher costs results.</td></tr>
<tr><td>Implementation Length</td><td>It has a shorter implementation period.</td><td>It has a lengthier implementation per</td></tr>
<tr><td>Examples</td><td>Examples include A* Search and Best-First Search.</td><td>Examples include Uniform-Cost Searc Iterative Deepening Search.</td></tr>
</table>
At least difference on 3 parameters 1.5 mark, 0.5 marks for example</td><td>2</td><td>IT3201.3</td></tr>
</table>

SECTION B (Concept Based Questions)

Q 4	Given the initial and final states of an 8-puzzle, find out a) if the problem is solvable and b) show clearly the next best 3 moves to solve it, using a suitable heuristic. INITIAL STATE GOAL STATE 1 2 3 1 2 3 4 6 => 4 5 6 7 5 8 7 8 1 mark for part a, 1 mark for heuristic 2 mark for each level in part b	4	IT3201.1
Q 5	What is resolution in Propositional logic. Given the set of premises: 1. (P →Q) →Q 2. (P→P) →R 3. (R →S)→ ¬(S →Q) Conclude 'R' by applying resolution. 2 mark for conversion to clausal form 2 mark for resolution proof.	4	IT3201.4
Q 6	Choose a domain that you are familiar with and write PEAS description of an agent for the environment. Characterize the environment as being accessible, deterministic, episodic, static, and continuous or not. Discuss agent architecture which suits the best for this domain? 1 mark for defining suitable problem 1 mark for PEAS 1 Mark for environment characteristics 1 mark for choosing suitable Agent	4	IT3201.2
Q 7	Discuss A* heuristic search technique. Solve the following graph using A* algorithm to find the optimal solution to reach to node J from the starting state A.  **Path- A → F → G → I → J** - A* search tech explanation 1 mark	4	IT3201.3

	correct path 1 mark A* Process with respect to graph 2 mark		
SECTION-C (Analytical Based Questions)			
Q 8	Specify the Predicate formulas for the following sentences, derive their CNF, and resolve the required Query. 1. Voting will be done in each constituency. 2. Whichever party candidate has the maximum votes wins the constituency and gets the seat. 3. There are 543 constituencies in all. 4. If a party wins more than half of the seats get a clear majority. 5. If a party gets a clear majority forms the government. 6. Party A wins 100 seats. 7. Party B wins 300 seats. 8. Others win the remaining 143 seats. Prove that Party B forms the government. (Hint. You might need to add few obvious sentences on your own. E,g,: If a party wins a constituency it gets one seat. 3 marks for writing WFFs 3 marks for conversion to CNF 2 Marks for resolving query.	8	IT3201.4

① $(P \to Q) \to Q$

$(\neg P \vee Q) \to Q$

$\neg(\neg P \vee Q) \vee Q$

$(P \wedge \neg Q) \vee Q$

$(P \vee Q) \wedge (\neg Q \vee Q)$

$(P \vee Q)$

② $(P \to P) \to R$

$(\neg P \vee P) \to R$

$\neg(\neg P \vee P) \vee R$

$(P \wedge \neg P) \vee R$

$(P \vee R) \wedge (\neg P \vee R)$

③ $(R \to S) \to \neg(S \to Q)$

$(\neg R \vee S) \to \neg(\neg S \vee Q)$

$(\neg R \vee S) \to (S \wedge \neg Q)$

$\neg(\neg R \vee S) \vee (S \wedge \neg Q)$

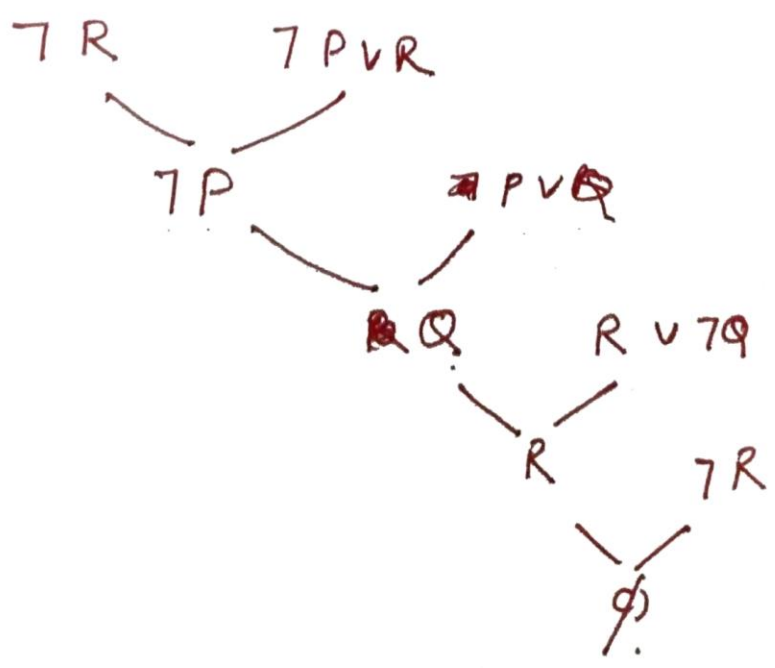
$(R \wedge \neg S) \vee (S \wedge \neg Q)$

$(R \vee S) \wedge (\neg S \vee S) \wedge (R \vee \neg Q) \wedge (\neg S \vee \neg Q)$

$(R \vee S) \wedge (R \vee \neg Q) \wedge (\neg S \vee \neg Q)$

① $P \vee Q$
② $P \vee R$
③ $\neg P \vee R$
④ $R \vee S$
⑤ $R \vee \neg Q$
⑥ $\neg S \vee \neg Q$
⑦ $\neg R$. (Start with.

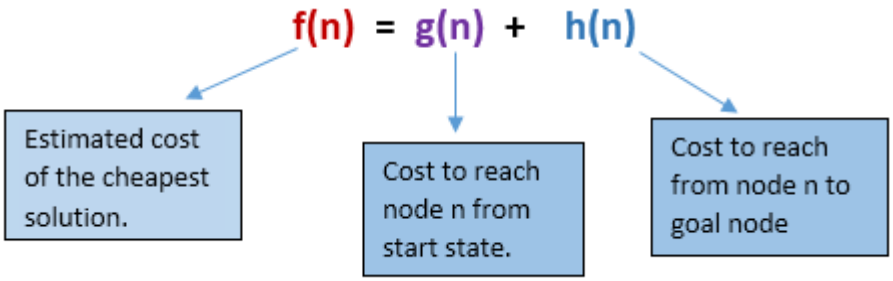
Prove R.



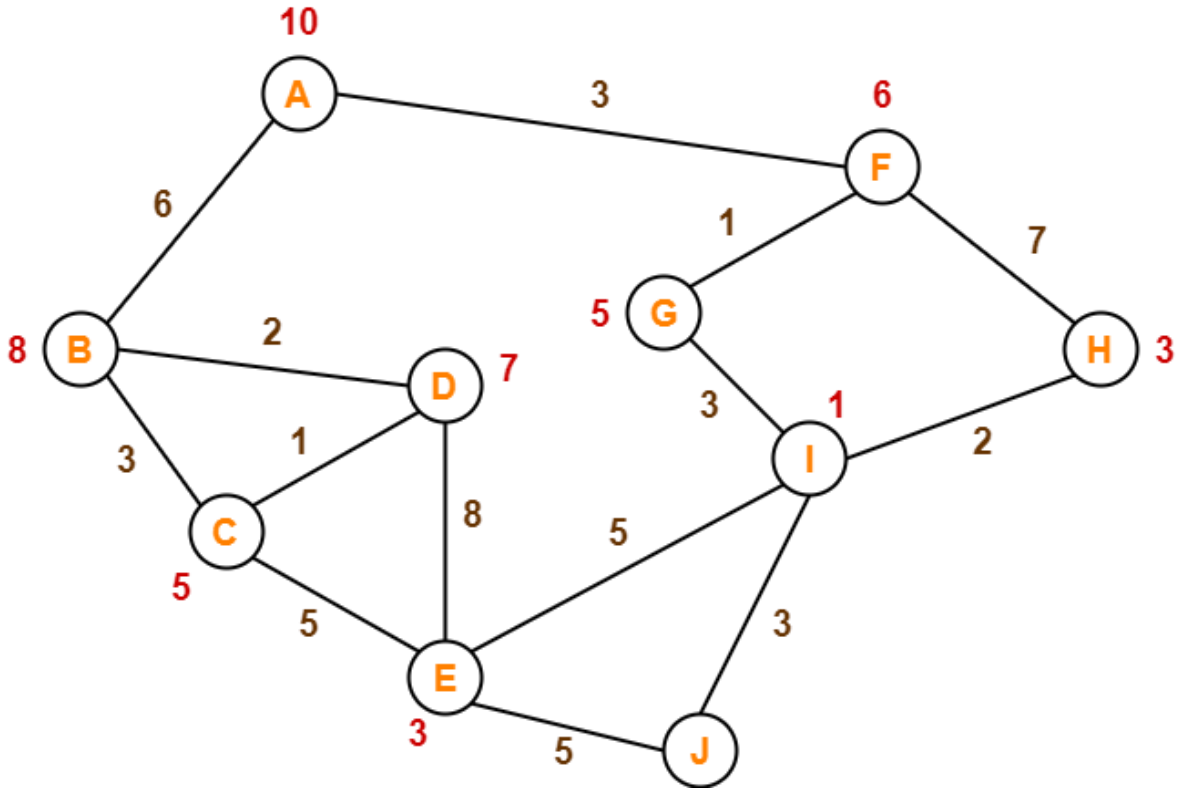
A* Search Algorithm:

A* search is the most commonly known form of best-first search. It uses heuristic function h(n), and cost to reach the node n from the start state g(n). It has combined features of UCS and greedy best-first search, by which it solve the problem efficiently. A* search algorithm finds the shortest path through the search space using the heuristic function. This search algorithm expands less search tree and provides optimal result faster. A* algorithm is similar to UCS except that it uses g(n)+h(n) instead of g(n).

In A* search algorithm, we use search heuristic as well as the cost to reach the node. Hence we can combine both costs as following, and this sum is called as a **fitness number**.



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.

Solution-

Step-01:

- We start with node A.
- Node B and Node F can be reached from node A.

A* Algorithm calculates f(B) and f(F).

- f(B) = 6 + 8 = 14
- f(F) = 3 + 6 = 9

Since f(F) < f(B), so it decides to go to node F.

Path- A → F

Step-02:Node G and Node H can be reached from node F.

A* Algorithm calculates f(G) and f(H).

- f(G) = (3+1) + 5 = 9
- f(H) = (3+7) + 3 = 13

Since f(G) < f(H), so it decides to go to node G.

Path- A → F → G

Step-03:Node I can be reached from node G.

A* Algorithm calculates f(I).

f(I) = (3+1+3) + 1 = 8

It decides to go to node I.

Path- A → F → G → I

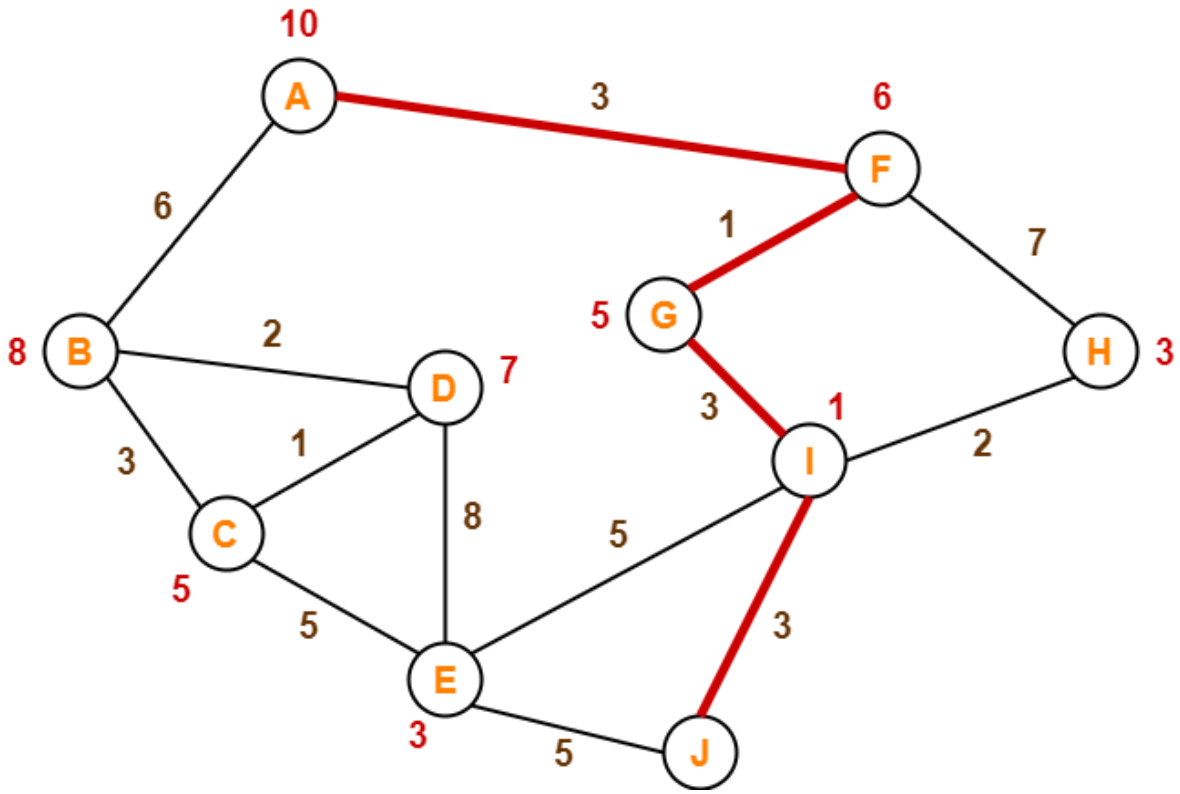
Step-04: Node E, Node H and Node J can be reached from node I.

A* Algorithm calculates f(E), f(H) and f(J).

- f(E) = (3+1+3+5) + 3 = 15
- f(H) = (3+1+3+2) + 3 = 12
- f(J) = (3+1+3+3) + 0 = 10

Since f(J) is least, so it decides to go to node J.

Path- A → F → G → I → J


10
A
3
6
F
6
1
7
5
G
8
B
2
D
7
H
3
3
1
1
I
2
3
8
5
C
5
5
3
E
3
5
J

1. $\forall x_1$ Constituency$(X_1) \rightarrow$ VotingDone(X_1)

2. $\forall X_2 \forall P_1 \forall P_2 \forall Y_1 \forall Y_2 \forall V_1 \forall V_2$

Constituency$(X_2) \wedge$ Party$(P_1) \wedge$ Party$(P_2) \wedge$ PartyCandidate(P_1, X_2, Y_1)

$\wedge$ PartyCandidate$(P_2, X_2, Y_2) \wedge$ NGetVotes(Y_1, V_1)

$\wedge$ NGetVotes$(Y_2, V_2) \rightarrow \wedge$ GT$(V_1, V_2) \wedge$ NE(Y_1, Y_2)

2b. $\forall X_3 \forall P_3 \forall Y_3$ WinConstituency$(X_3, P_3, Y_3) \rightarrow$ WinsConstituency(X_2, P_1, Y_1) $\rightarrow$ GetSeat(X_3, P_3, Y_3)

3. TotalSeats = 543

6. SeatsWonByParty$(A, 100)$ { Implied: Party(A), Party(B)

7. SeatsWonByParty$(B, 300)$

~~8. SeatsWonBy~~

4. $\forall P_4 \forall S_1$ Party$(P_4) \wedge$ SeatsWonByParty(P_4, S_1)

$\wedge$ GT$(S_1,$ TotalSeats$/2) \rightarrow$ GetsClearMaj(P_4)

5. $\forall P_5$ Party$(P_5) \wedge$ GetsClearMaj$(P_5) \rightarrow$ FormsGovt(P_5)

8. $\forall P_6 \forall S_2$ SeatsWonByParty$(P_6, S_2) \wedge$ NE$(P_6, A) \wedge$ NE(P_6, B)

$\rightarrow$ LT$(S_2, 143)$

~~9. $\forall S_3 \forall S_4$ LT$(S_3, S_4) \rightarrow$ GT(S_4, S_3)~~

Ques & Solution MTE ~~AI~~ ML 2023-24

CNF

3. Total Seats = 543

6a Seats Won By Party (A, 100) 6b Party(A)

7a Seats Won By Party (B, 300) 7b Party(B)

4. ¬ Party(P_4) ∨ ¬ Seats Won By Party(P_4, S_1) ∨ ¬GT(S_1, Total Seats/2) ∨ Gets Clear Maj(P_4)

5. ¬ Party(P_5) ∨ ¬ Gets Clear Maj(P_5) ∨ Forms Govt(P_5)

8. ¬ Seats Won By Party(P_6, S_2) ∨ ¬ NE(P_6, A) ∨ ¬ NE(P_6, B) ∨ LT(S_2, 143)

Prove: Forms Govt(B)

Contradiction ¬ Forms Govt(B)