Artificial Intelligence Assignment No: 2

P1] In following table, Select correct definition of each term. the first one is done.

→ Search Node — Represent a state in state space

State Space - All states reachable from initial state by sequence of action

link between Nodes :- Sequence of states connected by sequence of actions

frontier - Set of all leaf nodes available for expansion at any given time

Heuristic function - Estimates cost of cheapest path from current state to goal state

Optimal Search - Guaranteed to find lowest cost among all accessible solutions

Expand State :- Apply each legal action to a state generating new set of states

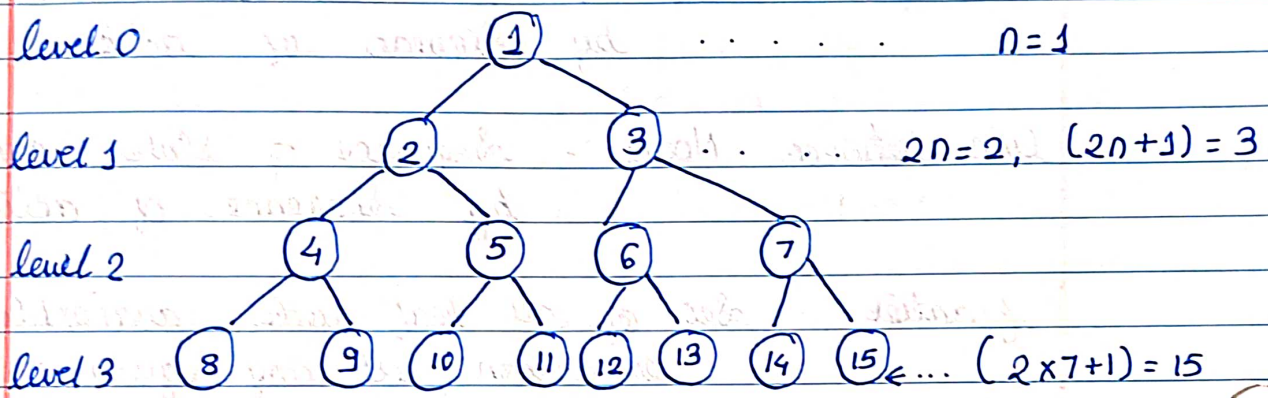
Path - Sequence of states connected by a sequence of action

Search strategy - how Search algorithm choose which node to expand Next I. Action - represent an action in State Space

Branching factor - maximum number of successor of Node

P2 Consider state space where the start state is number 1 and successor function for state n returns two states, number 2n and 2n+1.

a] Draw the portion of state space for state 1 to 15. use numerical order as the tiebreaker.



b Suppose the goal state is 11. list the order in which nodes will be visited for breadth-first search, depth-limited search with limit 3, and iterative deepening depth first search.

→ goal state : 11

→ Breadth first search (BFS)

Visited Node	frontier Set.
1	2, 3
2	3, 4, 5
3	4, 5, 6, 7
4	5, 6, 7, 8, 9
5	6, 7, 8, 9, 10, 11

6	7, 8, 9, 10, 11, 12, 13
7	8, 9, 10, 11, 12, 13, 14, 15
8	9, 10, 11, 12, 13, 14, 15
9	10, 11, 12, 13, 14, 15
10	11, 12, 13, 14, 15
11	12, 13, 14, 15

Thus for Goal Node 11.
The goal visited using BFS are.

1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10 → (11)
Goal Node

b.2] Goal Node : 11
using Depth first Search whose limit is three.

Visited Node	frontier
1	2, 3
2	3, 4, 5
4	3, 5, 8, 9
8	3, 5, 9
9	3, 5
5	3, 10, 11
10	3, 11
11	

Thus for Goal Node 11.
using Depth first Search the goal visited

1 → 2 → 4 → 8 → 9 → 5 → 10 → (11)
Goal Node

b.3] Iterative deepening depth first Search.
goal Node : 11.

The nodes will be visited based on limit of each step & will stop at last level or when goal is found. Thus at each iteration.

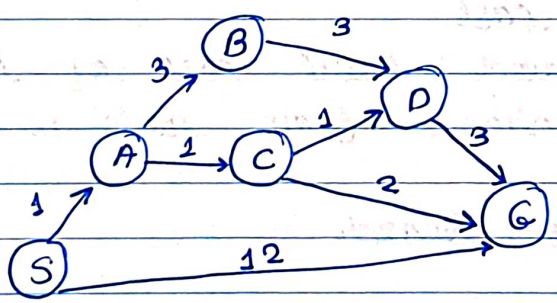
level 1 limit → 1 : 1 → 2 → 3 (level 0 - 1
level 1 → 2, 3)

level 2 limit → 2 : 1 → 2 → 4 → 5 → 3 → 6 → 7
(level 0 - 1
level 1 - 2, 3
level 2 - 4, 5, 6, 7)

level 3 limit → 3 : 1 → 2 → 4 → 8 → 9 → 5 → 10 → (11) goal.

(level 3 - 8, 9, 10, 11).

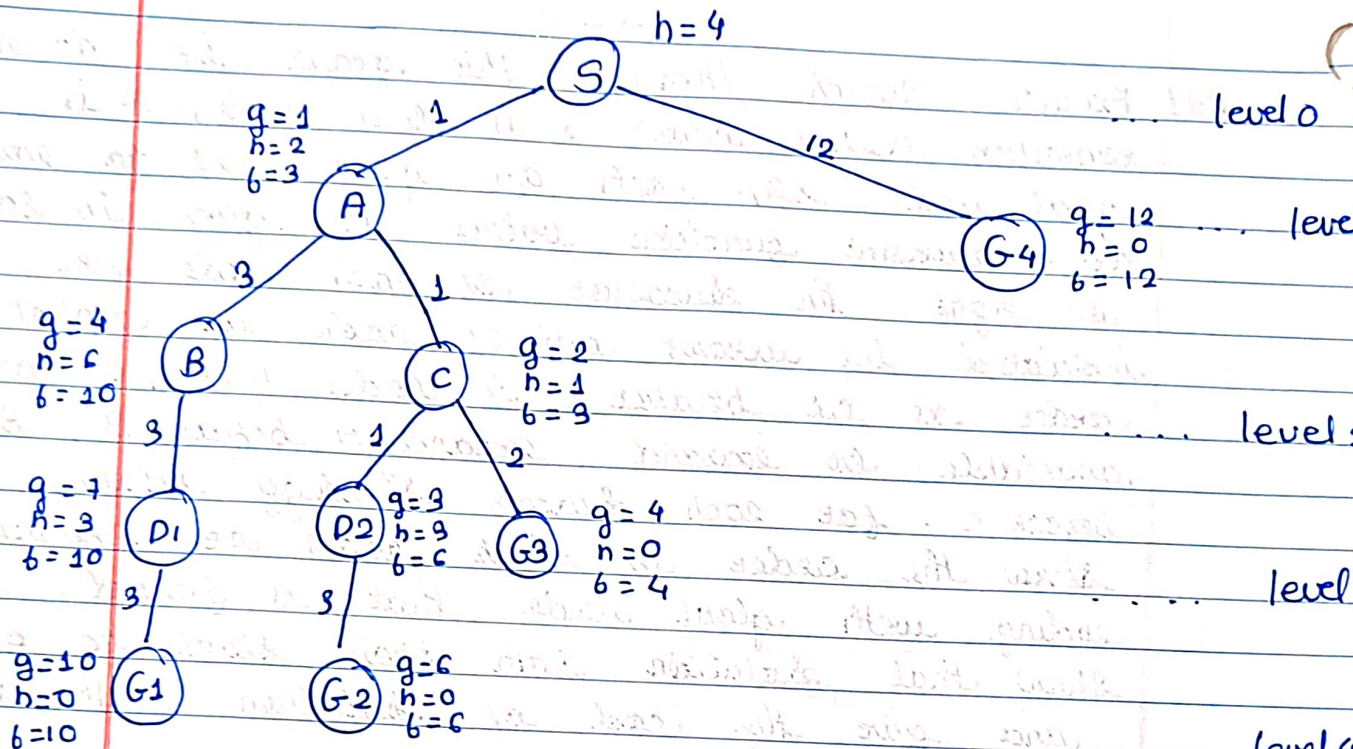
P3] Execute Search through this graph (i.e do not remember visited node) S is start node, G is goal node. Step costs are given next to each arc. heuristic function values are given in table on right. the Successor of each node are indicated by arrows out of node use alphabetical order as tie breaker, if nodes A, B, C are available to expand, expand A before B, B before C. for each Search Strategy below, Show the order in which nodes are expanded ending with goal node that is found. Show that Solution path from Start to goal and give the cost of Solution path is found.



State	h(n)
S	4
A	2
B	6
C	1
D	3
G	0

→ for the given tree. Drawing the Search tree.
Now G being the goal Node
Can be visited from 4 different Path hence for every trace using different goal Node
Notation (G1, G2, G3, G4)

The Node D is also traced two time hence for every trace using different notation of D



h = heuristic function Value
g = Path cost
f = estimated total cost of best path that continous from node n to goal.

3.a] depth first Search.

Visited Node	Frontier
S	A, G4
A	B, C, G4
B	C, D, G4
D1	G1, G4, C
G1	

order of expansion :- S → A → B → D → G
Path → S → A → B → D → G
Cost of path :- 1 + 3 + 3 + 3 = 10

3.b] uniform cost Search

this Search considers the which ever is lower g(n) is set as frontier

Visited Node	frontier
S	A, G4
A	B, C, G4
C	B, D2, G3, G4
D2	B, G2, G3, G4
B	D1, D2, G3, G4.
(G3)	

order of expansion is : S, A, C, D, B, G

Path is $S \rightarrow A \rightarrow C \rightarrow D \rightarrow B \rightarrow G$

cost of Path is $1 + 1 + 2 = 4$

3.c greedy Search with h(n)

The nodes will be visited based on the lower h(n) value

Visited	frontier
S	A, G4
G4	

order of expansion :- S, G

Sol^n Path :- $S \rightarrow G$

Path cost :- 12.

$x - 4y \quad y = 4)$

3.d Iterative deepning depth first Search.
At each iteration the depth level limit is increased till the goal node is found.

	Visited Node	frontier
level 0	S	
level 1	S	A, G4
	A	G4
	goal Node ... (G4)	

order of expansion : level 0 - S
level 1 - S A G

Path found :- S → G

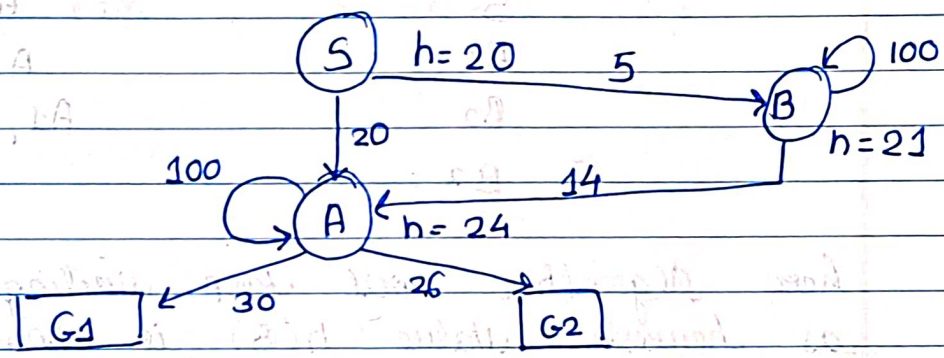
Path cost :- 12

3.e A* Search and heuristic function is f(n)
for A* search the total cost f(n) is calculated as f(n) = g(n) + h(n). for that node n.
the values are mentioned here in the tree Search against each node

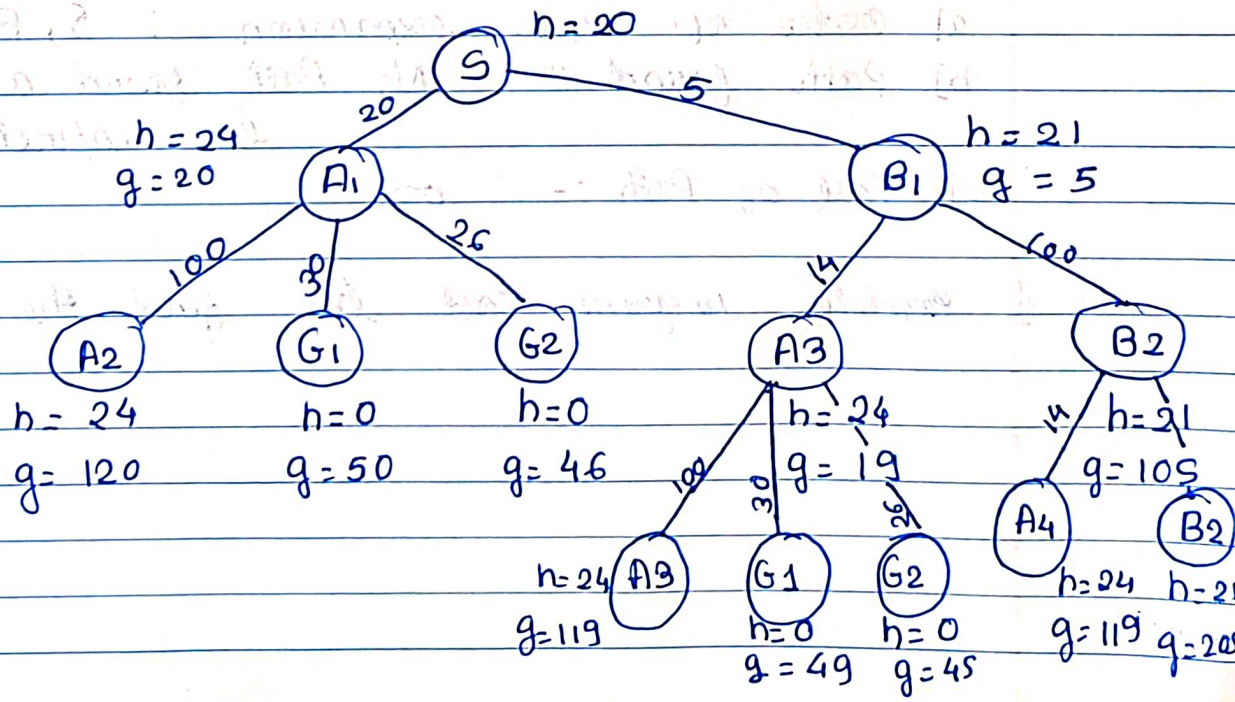
	Visited Node	frontier
	S	A, G4
f(A) = 3	A	B, C, G4
f(C) = 3	C	B, D2, G3, G4
f(G3) = 4	(G3)	
	↓ goal Node.	

Order of Node Expansion : S, A, C, G
Path found : S → A → C → G
Path Cost : 1 + 1 + 2 = 4

P4] Execute tree Search through this graph. Step cost are given next to each arc. heuristic values are given next to each node (as h=x). the successor of each node are indicated by arrow out of that node. child nodes are returned from left to right with an alphabeti and numerical order i.e children of S are (A, B) children of A are (A, G1, G2) and children of B are (A, B) in that order.



4.1] Execute greedy tree Search find the following
a. Order, Path found, Path Cost



A_1, A_2, A_3 → Same Node A through different Path
A_4

B_1, B_2 B_2 → Same Node B through different Path

G_1, G_2 → Same node G_1, through different Path
G_2, G_1

Visited Node	frontier
S	A_1, B_1
B_1	A_1, A_3, A_2
B_2	A_1, A_3, A_3, B_2
B_2	

Here Algorithm will keep visiting node B, as heuristic value h(B) is always less than h(A) of A. thus Solution Path will not be found & algorithm for greedy Search will go to infinitely.

a] Order of node expansion : S, B, B ... ∞
b] Path found :- No Path found as it goes to infinity
c] Cost of Path :- ∞

4.2] Execute uniform cost tree find the following

Visited	Frontier
S	A_1, B_1
B_1	A_1, A_3, B_2
A_3	A_1, B_2, A_3, G_1, G_2
A_1	A_2, G_1, G_2, B_2, A_3, G_1, G_2
G_2	

Order of expansion :- S, B, A, A, G_2

Path found : $S \rightarrow B \rightarrow A \rightarrow G_2$

Cost of Path :- $5 + 14 + 26 = 45$