Name: Bhushan Malpani
Div: D15C
Roll No: 33

05/05

Page No.
Date 30.-

# ASSIGNMENT - I

Q1) What is AI & considering the COVID-19 pandemic situation, how AI helped to survive and renovated our way of life with different applications?

⇒ Artificial Intelligence (AI) enables machines to think, learn and make decisions like humans. It includes technologies like machine learning, NLP & robotics.

## Applications:

1) Healthcare: AI helped in early diagnosis, vaccine development, and chatbot-based health assitance.
2) Contact Tracing: AI-powered apps tracked COVID-19 exposure ensuring public safety.
3) Remote work & Education: AI enhanced virtual meetings, online learning & productivity tools.
4) Supply chain & Delivery: AI optimized logistics & enabled autonomous deliveries.
5) Mental Health Support: AI-driven apps provided emotional & fitness assistance.

Q2) What are AI Agents terminology, explain with examples.

⇒ 1) Agent: An entity that interacts with the environment & makes decision based on inputs.
ex: A self-driving car perceives traffic signals & adjusts speed accordingly.

2) Performance measures: Defines how successful an agent is in achieving its goal.
ex: A self-driving car's performance measures could be minimizing accidents, fuel efficiency & travel time.

3) Behavior/Action of Agent: The action an agent takes based on its percepts.
ex: A robotic vaccuum cleaner moves around obstacles after detecting them.

4) Percept: The data an agent receives at a specific moment from sensors.
ex: A spam filter receives an email & detects keywords, sender info, and attachments.

5) Percept sequence: The entire history of percepts received by an agent.
ex: A chess playing AI remembers all previous moves in the game before making its next move.

6) Agent Function: A mapping from the percept sequence to an action.
ex: A smart thermostat analyzes past tempreture changes & adjusts heating accordingly.

Q3) How AI technique is used to solve 8-puzzle problem?
⇒ It consists of a 3x3 grid with 8 numbered tiles & one empty space, where the objective is to move the tiles around to match a predefined goal configuration.

Initial State:

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | | 6 |
| 7 | 5 | 8 |

This is the random starting configuration of the 8 puzzle with the tiles placed in a non-goal configuration.

2> Goal state : The goal is to arrange the tiles in a specific order with the blank space at the bottom right.

Goal State

1 2 3
4 5 6
7 8

* Solving the 8 Puzzle problem.

- AI search algorithms, such as breadth-first search (BFS), depth-first search (DFS) and A*, are commonly used :

1> Breadth-First Search (BFS):

- BFS is an uninformed search algorithm that explores all possible state level by level, starting from the initial state.
- BFS guarantees that the solution found is the shortest in terms of number of moves, but it can be very slow.

Advantages:

Guaranteed to find the optimal solution.

Disadvantages:

BFS has a high memory requirement, as it must store all the states at each level of exploration.

2> Depth-First Search (DFS):

- DFS is another uninformed search algorithm that explores one branch of the state space tree as deep as possible before backtracking.

Advantages:

DFS is more memory-efficient than BFS.

Disadvantages:

DFS can get stuck in deep, non-optimal paths & may not find the shortest solution.

Steps using A*:
- Compute Manhattan distance for each possible move.
- Choose the best move (lowest F(n))
- Repeat until reaching the goal state.

Q4) What is PEAS descriptor ? Give PEAS descriptor for following

1) Taxi driver:
- P : Minimize travel time, fuel efficiency, passenger safety, obey traffic rules.
- E : Roads, traffic, passengers, weather, obstacles, pedestrians
- A : Steering, accelerator, brakes, turn signals, horn.
- S : Camera, GPS, speedometer, radar, LiDAR, microphone

2) Medical Diagnosis System:
- P : Accuracy of diagnosis, treatment success rate, response time
- E : Patient records, symptoms, medical tests, hospital database
- A : Display screen, printed prescriptions, notifications
- S : Patient input, lab reports, electronic health records

3) A music Composer:
- P : Quality of music, adherence to genre, audience engagement.
- E : Digital workspace, music production software, real time composition settings.
- A : Audio output, digital instrument selection, file saving/export
- S : User inputs, style preferences, tempo, feedback from listners, music theory contraints.

4) An aircraft Autolander:
P: Smooth landing, accuracy in reaching runway, passenger safety, fuel efficiency
E: Airspace, runway, weather, wind speed, visibility
A: Flight control, landing gears, brakes
S: GPS, airspeed indicator, gyroscope, radar, weather sensors

5) An essay Evaluator
P: Accuracy of grading, consistency, fairness, grammer
E: Digital text input, student essays, predefined grading criteria
A: Feedback generation, score assignment, ~~hand~~ highlighting errors, suggesting improvement.
S: Optical character recognition, NLP, grammer & spell checkers.

6) A robotic sentry gun for the keck lab.
P: Target accuracy, threat detection efficiency, response speed,
E: keck lab premises, intruders, lighting conditions, obstacles
A: Gun aiming system, firing mechanism, camera panning, alert system
S: Motion detectors, infrared sensors, cameras, LIDAR, radar

Q5) Categorize a shopping bot for an offline bookstore according to each of six dimension (fully/partially observable, determinstic/stochastic, episodic/sequential, static/dynamic, discrete/continuous, single/multi agent)

⇒ 1) Partially Observable: The bot may not have complete visibility.
2) Stochastic: The enviroment is unpredictable.
3) Sequential: Each decision bot makes affects future states
4) Dynamic: The bookstore environment changes over time
5) Discrete: Bot choose discrete choices (selecting books)
6) multi agent: The bot interacts with multiple entities.

Page No.
Date

Q6) Differentiate Model based & Utility based agent

⇒

| Model Based Agent | Utility Based Agent |
|---|---|
| 1) Maintains an internal model of the environment to make decision. | 1) Uses a utility function to measure performance & make option choices. |
| 2) Relies on stored knowledge & updates the model. | 2) Chooses actions based on maximizing expected utility. |
| 3) Can adapt to changing environment by updating the internal model. | 3) More flexible & goal-oriented, adapting to changes dynamically. |
| 4) Moderate complexity due to model maintainance. | 4) Higher complexity due to the need to compute utilities for different actions. |
| 5) Ex: Self-driving car that predicts pedestrian movement | 5) A self driving car that evaluates & routes & selects the best one. |

Q7) Explain the architecture of a knowledge based agent & learning Agent.

⇒ 1. Knowledge-Based Agent Architecture

- A knowledge-based agent is an intelligent that makes decisions using knowledge base (KB) and reasoning machanism.

Architecture Component:

1) knowledge base: Stores fact, rules & heuristics about the world.
2) Inference Engine: Use logical reasoning (FOL) to derive new knowledge from the KB.
3) Perception Module: Collects data from sensor & update the KB.
4) Action selection Module: Chooses appropriate actions based on reasoning outcomes.

5) Communication Module: Allows interaction with other agents

Working Process:

- The agent perceives the environment & updates its KB.
- The interference engine applies logical rules to infer new knowledge.
- The agent decides on action and executes it.
- The KB is continuously updated to improve decision-making.

2) learning Agent Architecture:

- A learning agent improves its performance over time by learning from past experiences & interactions with the environment

Architecture: components:

1) Learning Element: Analyzes feedback from the environment and improves knowledge.
2) Performance Element: Make decisions & executes actions.
3) Critic : Evaluates the agent's action & provides feedback.
4) Problem Generator: Suggests explatory actions to improve learning.

Working Process:

- The performances element selects an action.
- The critic evaluates the action & provides feedback
- The learning element updates the agents knowledge to improve future decisions.
- The problem generator suggests new strategies to explore better solutions.

Page No.
Date

Q8) What is AI? Considering the COVID-19 pandemic situation, how AI helped to survive & renovated our way of life with different applications?

⇒ • Artifical Intelligence (AI) is the simulation of human intelligence in machines that can learn, reason & make decision. AI system process large datasets, recognize patterns & automate tasks, enhancing efficiency across institutes.

AI's role in the COVID-19 pandemic:

1) Healthcare & Diagnosis: AI analyzed CT scans & detected COVID-19 faster.

2) Chatbots & virtual assistants: Provided instant medical advice.

Q9) Convert the Following to predicates:

a) Anita travels by car if available otherwise travels by bus.

⇒

carAvailable → Travel by Car (Anita)

¬ Car Available → Travel By Bus (Anita)

b) Bus goes via Andheri and Goregaon.

goesVia (Bus, Andheri) ∧ ~~Goregaon~~ goesVia (Bus, Goregaon)

c) Car has punture & is not available

Puncture (car) → ¬ ~~car~~ Available (car)

Q) Will anita travel via Goregaon

From (c):

Punture (car) is true, punture (car) → ¬ Available (car)

For (a):

¬ carAvailable → Travel By Bus (Anita)

From b:

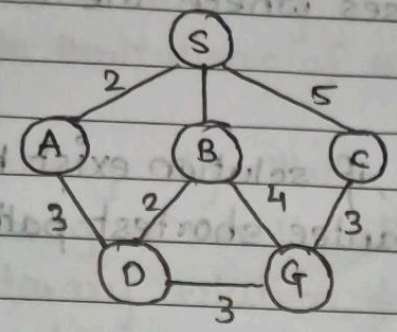
Goes via (Bus, Goregaon)

∴ Anita will travel via goregaon.

Galaxy S24

Page No.
Date

Q10) Find the route from S to G using BFS.




| Current Node | Queue | Visited node |
|---|---|---|
| ~~S~~ | A B C | S |
| ~~A~~ | B C | |

~~Step 1:~~

~~Selecting least cost between (A,2) (B~~

| Current Node | Queue | Visited Node. |
|---|---|---|
| S | A B C | S |
| ~~A~~ | B C D G | S→A |
| B | C D G | S→A→B |
| C | D G | S→A→B→C |
| D | G | S→A→B→C→D |
| G | | S→A→B→C→D→G |

Path S→A→B→C→D→G

Q11) What do you mean by depth limited search? Explain iterative Deepening search with example.

→ Depth-Limited Search (DLS):

• Depth-Limited Search (DLS) is a variation of Depth-First Search (DFS) where the search is limited to a predefined depth. This helps prevent the algorithm from going too deep into the search tree

avoiding infinite loops in cases where the tree is unbounded.

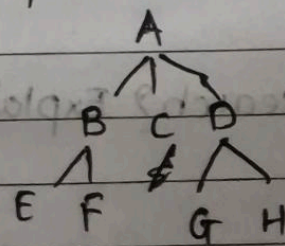
Key features:
1) Completeness: Not complete, if solution exist beyond depth limit.
2) Optimality: Doesn't guarantee shortest path.
3) Time Complexity: $O(b^d)$
4) Space Complexity: $O(b \times L)$

- When the search space is large or infinite
- If you know the appropriate depth where the solution may lie.

* Iterative Deepening Search (IDS):
- Iterative Deepening Search is a combination of DFS & BFS. It performs a series of Depth-limited searches with increase depth limits until a solution is found. This combines the space efficiently of DFS & the completeness of BFS.

Key Features:
1) Completeness: Yes, it will find solution if it exists.
2) Optimality: Yes, if unweighted.
3) Time Complexity: $O(b^d)$
4) Space Complexity: $O(b \times d)$

Example




1) Depth 0: Explore [A] → No solution.
2) Depth 1: Explore [A, B, C, D] → No solution.
3) Depth 2: Explore [A, B, C, D, E, F, G, H] → Solution found at H

Page No.
Date

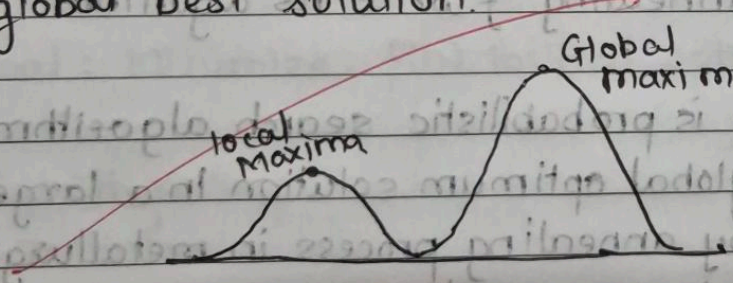
Q.12) Explain Hill Climbing and its drawbacks in detail with example Also state limitations of steepest-ascent hill climbing.

⇒

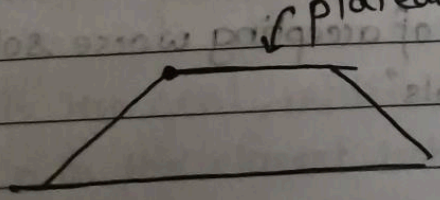
Hill climbing algorithm:
Hill climbing is an iterative search algorithm that starts with an arbitrary solution & makes small changes to improve it. The goal is to reach the optimal solution by continuously moving toward better states.
It is a local search algorithm that evaluates the neighbouring states & moves to the best one.

Types of hill climbing:
1) Simple hill climbing
2) Steepest-Ascent Hill climbing
3) Stochastic Hill climbing.

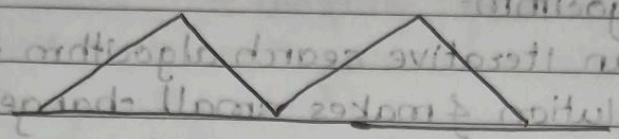
* Drawbacks of Hill Climbing:
1) local Maxima: Gets stuck at a peak that is not the global best solution.




2) Plateau: A flat region where all neighbouring values are the same, preventing progress.



3> Ridges: Steep paths where small moves are ineffective because the goal lies along a narrow ridge.



* Limitation of steepest-Ascent Hill climbing:

1> Increased Time complexity: Evaluating all neighbors requires more computation time.

2> local Optima: It can still stuck in local maxima, just like simple hill climbing.

3> Plateau Issue: Can't move forward if all neighbour have same value.

4> No backtracking: The algorithm can't revisit earlier states, even if a better solution lies there.

Q13> Explain simulated annealing & write its algorithm.

⇒

- Simulated annealing is probabilistic search algorithm used to find an appropriate global optimum solution in a large search space. It is inspired by annealing process in metallurgy, where metals are heated & slowly cooled to reduce defects & improve structure.
- Unlike hill climbing, which only moves to better solution, simulated annealing allows occasional moves to worse solutions to escape local optima. The probability of accepting worse solutions decrease over time as the system "cools".

Page No.
Date

Algorithm:
1) Initial solution: S
2) Initial tempreture: T
3) Cooling rate $\alpha$
4) Cost function f(s)
5) Stopping Condition (min tempreture).

Q14) Explain A* Algorithm with an example.

⇒ A* algorithm is a widely used search algorithm in AI for finding the shortest path between two points. It is an informed search algorithm that combines the strengths of both Uniform Cost Search and Greedy Best-first Search.

A* evaluates each nodes using the following cost function.

$$f(n) = g(n) + h(n)$$

Where:
f(n) ⇒ Total estimated cost to reach the goal through node n.
g(n) ⇒ Actual cost from the start node to node n.
h(n) ⇒ Heuristics estimate of the cost from node n to the goal.

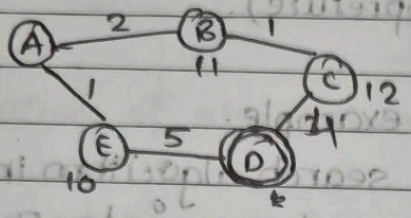
Goal: Minimize f(n) to find optimal path.

Algorithm Steps:
1) Initialize
- Open list (to track nodes to be explored)
- Closed list (to track explored nodes).

2) Add the start node to the open list.
3) Repeat until Goal is found.
- Select the node n from the open list with lowest f(n).
- IF n is the goal, return the path.
- Move n to the closest list.

- For each neighbour of n:
  - If the neighbour is in the closet list, skip it
  - If the neighbour is not in the open list, add it
  - Update the g, h and f values.

4) Return failure if no path is found




Start node: A

$A \rightarrow B \Rightarrow f(n) = g(n) + h(n)$

$= 2 + 11$

$= 13$

$A \rightarrow E \Rightarrow f(n) = g(n) + h(n)$

$= 1 + 10$

$= 11$

Select

$A \rightarrow E \rightarrow D = f(n) = g(n) + h(n)$

$= 1 + 5 + 0$

$= 6$

$A \rightarrow B \rightarrow C \Rightarrow f(n) = g(n) + h(n)$

$= 2 + 1 + 12$

$= 15$

$A \rightarrow B \rightarrow C \rightarrow D \Rightarrow f(n) = g(n) + h(n)$

$= 2 + 1 + 4$

$= 7$

Shortest path $A \rightarrow E \rightarrow D$ cost = 6

Page No.
Date

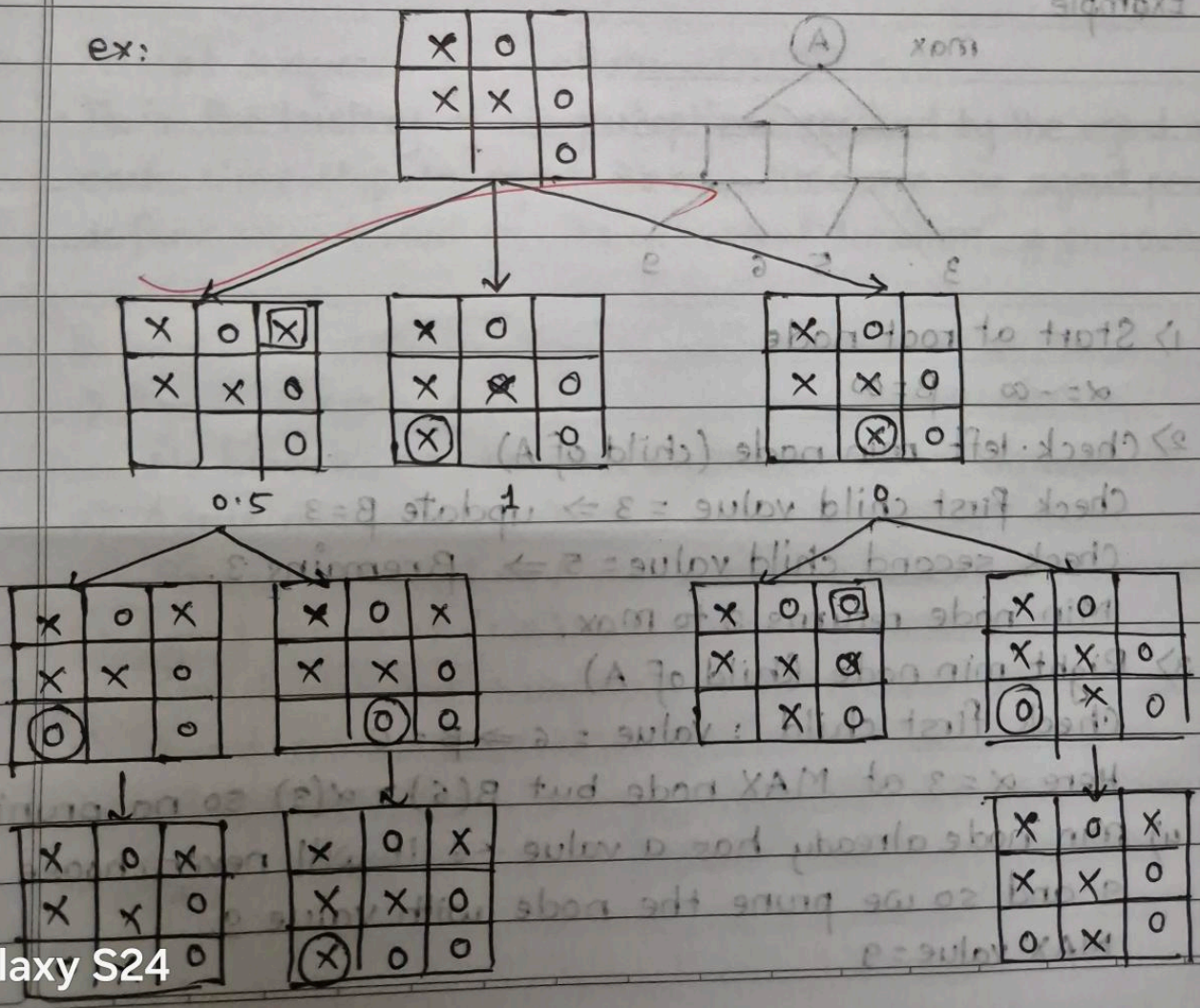
Q15) Explain min-max algorithm & draw game tree for tic-tac-toe game

⇒ • The min-max algorithm is a decision making algorithm used in 2 player games. It assumes one player [MAX] tries to maximize to score & other tries to minimize the score.

Algorithm:

1) Generate game tree.
2) Assign scores
3) MAX picks highest value from children
   MIN picks lowest value.
4) Repeat until root node is evaluated starting a bottom up aproach.

ex:

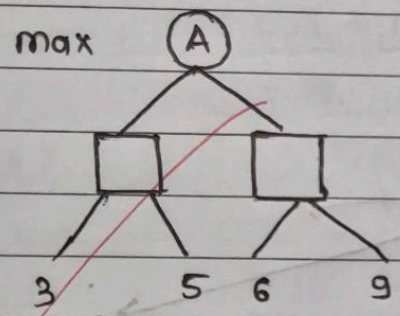


Q16) Explain alpha beta pruning algorithm for adversial search with example

⇒ Alpha beta pruning is an optimization technique used in minimax algorithm to reduce the number of nodes evaluated in adversial search problems like game playing AI (eg: chess).

Alpha beta pruning includes
Alpha (α): The best maximum score that the maximizing player can guarantee so far.
Beta (β): The best minimum score that the minimizing player can guarantee so far.

Example




1) Start at root node
$\alpha = -\infty$ $\beta = \infty$

2) Check left min node (child of A)
Check first child value = 3 ⇒ update $\beta = 3$
Check second child value = 5 ⇒ $\beta$ remains 3.
Min node returns 3 to max.

3) Right min node (child of A)
Check first child : value = 6 ⇒ $\beta = 6$
Here $\alpha = 3$ at MAX node but $\beta(6) > \alpha(3)$ so no pruning.

4) min node already has a value ≤6 it will never choose 9 and so we prune the node with value 9.
MAX value = 9

Page No.
Date

Q17) Explain WUMPAS world environment, giving its PEAS description. Explain how percept sequence is generated.

⇒ • The WUMPUS World environment is a simple grid-based environment used in AI to study intelligent agent behaviour.
• In uncertain environment, it is a turn based environment where an agent must navigate a case to find gold while avoiding hazards like pits & a monster called wumpas.

PEAS:

P: Grabbling gold, exit safely, Do not fall into pit.
E: 4x4 grid, agent, wumpus, pits, gold.
A: Move left, right, shoot, forward
S: Breeze (near pit), glitter (near gold), lump.

Percept sequence generation:

• It is the history of all perceptions received by the agent at each time step, ~~the agent~~ At each time step the agent perceives information based on its ~~as~~ current location & surrounding.

Example:

1) Agent starts at (1,1)
No breeze, no stench, no glitter → safe square.
2) Agent moves to (2,1)
Breeze detected → A pit is near but not on same square.
3) Agent moves at (1,2):
Stench detected → wumpus is in adjacent cell.
4) Agent moves to (2,2):
Glitter detected → ~~wumpus is in adjacent~~ gold is near.
5) Agent moves back to (1,1) & climbs out.

Q18) Solve for crypt Arithematic

SEND + MORE = MONEY

⇒ Step 1:

m=1 (Sum of 4 digit is 5 digit therefore carry from 4th digit).

```
  S E N D
  1 0 R E
---------
1 0 N E Y
```

Step 2:

~~Assume:~~

~~E+0 = 10+N~~ Since carry is generated for 5th digit

~~then~~

S+1 = 0+10

This is possible only if 9=9 ∴ 9+1 = 0+10

0=0

```
  9 E N D
+ 1 0 R E
---------
1 0 N E Y
```

Step 3:

E + 0 = N (This is not possible as E ≠ N)

∴ E + 0 + ~~N = 10~~

lets assume

E = 5

∴ N = 5 + 1 (carry)

N = 6

```
  9 5 6 0
+ 1 0 R 5
---------
1 0 6 5 Y
```

Page No.
Date

$6 + R = E + 5$

$\therefore R = 8$

$6 + 9 = 5 + 10$

$$\begin{array}{r} 9\ 5\ 6\ D \\ +\ 1\ 0\ 8\ 5 \\ \hline 1\ 0\ 6\ 5\ Y \end{array}$$

$D + 5 = Y$

We have $\{2, 3, 4, 7\}$ options left.
Since $(2, 3, 4)$ can't generate carry

$\therefore$ If $D = 7$

$$\begin{array}{r} 9\ 5\ 6\ 7 \\ +\ 1\ 0\ 8\ 5 \\ \hline 1\ 0\ 6\ 5\ 2 \end{array}$$

$\therefore$ Final solution

$S = 9$
$E = 5$
$N = 6$
$D = 7$
$M = 1$
$O = 0$
$R = 8$
$Y = 2$

Q19) Consider the following axioms.

- All people who are graduating are happy, All happy people are smiling, someone is graduating

⇒

Representing these axioms in first order predicate logic.

$G(x)$ = $x$ is graduating.
$H(x)$ = $x$ is happy
$S(x)$ = $x$ is smiling

Translating axiom into predicate logic.

1) All people who are graduating are happy.

$\forall x : G(x) \rightarrow H(x)$

2) All happy people are smiling

$\forall x : H(x) \rightarrow S(x)$

3) Someone is graduating

$\exists (x)\ G(x)$

Convert each formula to clause form

1. Convert implication to clausal form.

$\forall x\ G(x) \rightarrow H(x)$

- Using implication removal

$\forall x\ (G(x) \vee H(x))$

- In clause form

$\{\neg H(x), H(x)\}$

2. $\forall(x) : H(x) \rightarrow S(x)$

- Using implication removal

$\forall x (\neg H(x) \vee S(x))$

- In clausal form

$\{\neg H(x), S(x)\}$

3. $\exists x G(x)$

- In clausal form : $\{G(x)\}$

Prove " is something using resolution

1) Collect clauses

1) $\{\neg G(x), H(x)\}$
2) $\{\neg H(x), S(x)\}$
3) $\{G(x)\}$

2) Apply resolution

- Resolve (1) $\{\neg G(x), H(x)\}$ with $\{G(x)\}$

Substituting $x = a$

$\{\neg G(a), H(a)\}$

$\therefore$ we have $G(a)$, resolving gives $\{H(a)\}$

- Resolve (2) $\{\neg H(x), S(x)$ with $\{H(a)\}$

Substituting $x = a$

$\{\neg H(a), S(a)\}$

- Since, we have $H(a)$, resolving given

$\{S(a)\}$

Since, we derived $S(a)$, we conclude that someone (a) is smiling.

Page No.
Date

Q20) Explain modus ponen with suitable example.

⇒ Modus ponen is a fundamental rule of interference in propositional logic that follows us to deduce a conclusion from a conditional statement & its antecedant.

It follows the form

1) $P \rightarrow Q$ (If P then Q)

2) P (P is true)

$\therefore Q$ (Q must be true)

Example:

1) If it is cold, you wear sweater

$P \rightarrow Q$

2) It is cold $\rightarrow P$

$\therefore$ You wear sweater Q

Q21) Explain forward and backward chaining algorithm with the help of example.

⇒ Forward Chaining: It starts with given facts and applies inference rules to derive new facts until the goal is reached. It is a data driven approach because it begins with known data & work forward to react a conclusion.

Ex: Diagnosing a disease.

Rules:

1) If a person has fever & cough they might have flu.

2) If a person has sore throat and fact, they might have cold

Facts:

1) The patient has a fever

2) The patient has cough.

Page No.
Date

Inference

1) Fever + cough → flu (rule 1 applies)
2) Conclusion, the patient might have flu.

Backward Chaining:

It starts with goal & works to backward by checking what facts are needed to support it. It is a goal driven approach

Example : Diagonising a disease
Goal: Determine if patient has flu.

Rules:

1) Fever ∧ cough → flu
2) Sour throat ∧ fever → Cold

Process:

1) We want to prove flu.
2) Looking at rule 1 : [Fever ∧ cough] → flu, we need to check if patient has fever & cough.
3) We check our known facts.
   - Patients has fever
   - Patient has cough.
4) Since, both conditions are met, we confirm flu is true.