SCHEME : K

Name : _____

Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

AI IN ROBOTICS
(314333)

ELECTRONICS ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF
TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best-in-class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the following

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education

A Laboratory manual

for

AI IN ROBOTICS

(314333)

K-Scheme

Semester – IV

(AO)

Maharashtra State

Board of Technical Education, Mumbai

(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)
4th Floor, Government Polytechnic Building, 49,
Kherwadi, Bandra (East), Mumbai- 400051.

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr./Ms.…….....

Roll. No.……. of Fourth Semester of Diploma in ……....

.....…….....

of Institute ……..……

(Code: ……) has completed the term work satisfactorily in course **AI IN ROBOTICS (314333)** for the academic year 20…….to 20……. as prescribed in the curriculum.

Place: ……. **Enrollment No: ……**

Date: …… **Exam Seat No: …….**

Subject Teacher **Head of department** **Principal**

Seal of Institute

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much-needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'K' Scheme curricula for engineering diploma programmes with outcome-based education as the focus and accordingly, a relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher, instructor and student realize that every minute of the laboratory time needs to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome- based curriculum, every practical course has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through "chalk and duster" activity in the classroom situation. Accordingly, the 'K' scheme laboratory manual development team designed the practical to focus on the outcomes, rather than the traditional age-old practice of conducting practical to 'verify the theory" (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the predetermined outcomes. It is expected. from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through the procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

The basic aim of the course AI IN ROBOTICS (314333) is to facilitate the diploma students to acquire an understanding of the fundamental concepts, theories, and principles that govern the design, operation, and application of AI in robotic systems.

Although the best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program Outcomes (POs)

PO1 Basic and Discipline specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the broad-based Electronic Engineering group program problems.

PO2 Problem analysis: Identify and analyze well-defined Electronic Engineering group program problems using codified standard methods.

PO3 Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of Electronic Engineering group program systems components or processes to meet specified needs.

PO4 Engineering Tools, Experimentation and Testing: Apply modern Electronic Engineering group program tools and appropriate technique to conduct standard tests and measurements.

PO5 Engineering practices for society, sustainability and environment: Apply appropriate Electronic Engineering group program technology in context of society, sustainability, environment and ethical practices.

PO6 Project Management: Use Electronic Engineering group program management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO7 Life-long learning: Ability to analyze individual needs and engage in updating in the context of Electronic Engineering group program technological changes.

List of relevant expected psychomotor domain skills

The following industry relevant skills of the identified competency "Simulate automated robotic systems through artificial intelligence concepts" are expected to be developed in student by undertaking the laboratory work as given in laboratory manual.

1. Determine initial state and goal state for a given problem.
2. Use relevant AI search strategies for problem solving.
3. Interpret different types of knowledge and reasoning techniques used in AI.
4. Apply the learning methods adopted in AI.
5. Apply the principles of AI in robotics.
6. Proper use of development tools, libraries, and frameworks..
7. Precise and optimized code to handle data accurately
8. Observe outputs or results systematically
9. Adopt proper procedure while performing the experiment.

Practical-Course outcome matrix

COURSE LEVEL LEARNING OUTCOMES (COs)

CO1. Determine initial state and goal state for a given problem.
CO2. Use relevant AI search strategies for problem solving.
CO3. Interpret different types of knowledge and reasoning techniques used in AI.
CO4. Apply the learning methods adopted in AI.
CO5. Apply the principles of AI in robotics.

Sr. No.	Title of the Practical	CO1	CO2	CO3	CO4	CO5
1	* Identification of initial state and goal state for a given 3- pegs problem	✓	-	-	-	-
2	Identification of initial state and goal state for a given problem on chessboard	✓	-	-	-	-
3	* Implementation of breadth first search algorithm	-	✓	-	-	-
4	Implementation of depth first search algorithm	-	✓	-	-	-
5	*Implementation of forward chaining algorithm	-	✓	-	-	-
6	Implementation of travelling salesman problem	-	✓	-	-	-
7	*Implementation of forward chaining algorithm	-	-	✓	-	-
8	Implementation of backward chaining algorithm	-	-	✓	-	-
9	Implementation of forward reasoning	-	-	✓	-	-
10	* Implementation of backward reasoning	-	-	✓	-	-
11	Implementation of Bayesian reasoning	-	-	✓	-	-
12	Implementation of data extraction	-	-	-	✓	-
13	* Develop a program to split dataset	--	--	--	✓	-
14	* Implementation of motion commands for robot using simulator	-	-	-	-	✓
15	Implementation of end effector command for a given robot	-	-	-	-	✓
16	Execution of robotic operations by bridging robotvision systems	-	-	-	-	✓
17	* Implementation of specific path movement of robot					✓
18	Implementation of painting operation with AI based robot					✓

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each experiment
3. Involve students in performance of each experiment.
4. Teacher should ensure that the respective skills and competencies are developed in. the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.
9. Teacher is expected to refer complete curriculum document and follow guidelines for implementation
10. At the beginning of the practical which is based on the simulation, teacher should make the students acquainted with any simulation software environment.

Instructions for Students

1. Listen carefully the lecture given by teacher about subject, curriculum, learning structure, skills to be developed.
2. Organize the work in the group and make record all programs.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and gain confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
6. Student shall refer technical magazines.
7. Student should develop habit to submit the practical on date and time.
8. Student should well prepare while submitting write-up of exercise.
9. Attach/paste separate papers wherever necessary.

Content Page

List of Practical's and Progressive Assessment Sheet

Sr. No.	Title of the Practical	Page no.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated sign of Teacher	Remarks (If any)
1	* Identification of initial state and goal state for a given 3- pegs problem	2					
2	Identification of initial state and goal state for a given problem on chessboard	8					
3	* Implementation of breadth first search algorithm	14					
4	Implementation of depth first search algorithm	19					
5	*Implementation of forward chaining algorithm	24					
6	Implementation of travelling salesman problem	28					
7	*Implementation of forward chaining algorithm	32					
8	Implementation of backward chaining algorithm	36					
9	Implementation of forward reasoning	41					
10	* Implementation of backward reasoning	46					
11	Implementation of Bayesian reasoning	50					
12	Implementation of data extraction	54					
13	* Develop a program to split dataset	58					
14	* Implementation of motion commands for robot using simulator	63					
15	Implementation of end effector command for a given robot	69					
16	Execution of robotic operations by bridging robotvision systems	75					
17	* Implementation of specific path movement of robot	81					
18	Implementation of painting operation with AI based robot	86					
	Total						

Note: Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No.1: *Identification of initial state and goal state for a given 3- pegs problem

I Practical Significance

To familiarize the students with the initial state and goal state for a given 3- pegs problem

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Determine initial state and goal state for a given problem.

IV Laboratory Learning Outcome(s)

- Identify initial state and goal state for 3 pegs problem.
- Write the steps to solve 3-pegs problem as a state space problem.

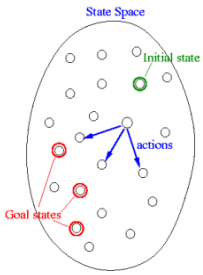
V Relevant Affective Domain related outcome(s)

Follow ethical practices
Handle tools and equipment carefully.

VI Relevant Theoretical Background

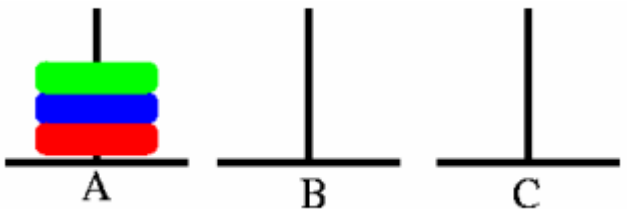
Search Problem

A search problem consists of the following:
• S: the full set of states
• S_0 : the initial state
• A:S→S is a set of operators
• G is the set of final states. Note that G ⊆S

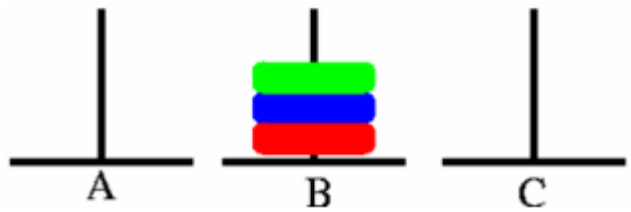


Consider the following problem. We have 3 pegs and 3 disks.
Operators: one may move the topmost disk on any needle to the topmost position to any other needle
In the goal state all the pegs are in the needle B as shown in the figure below.

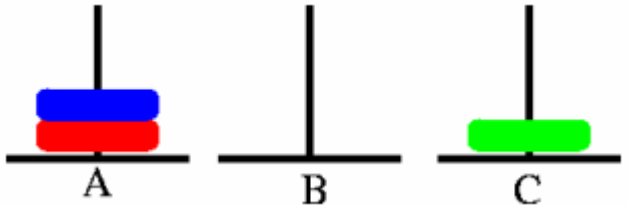
The initial state is illustrated below.



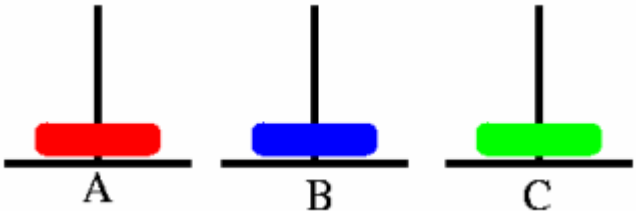
Now we will describe a sequence of actions that can be applied on the initial state.



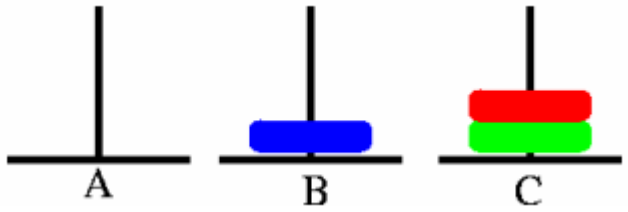
Step 1: Move A → C



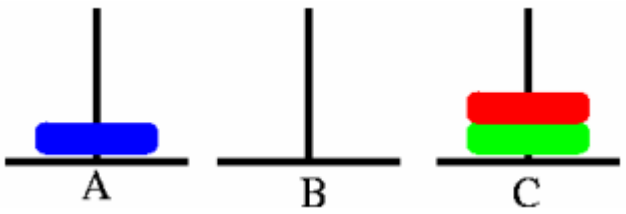
Step 2: Move A → B



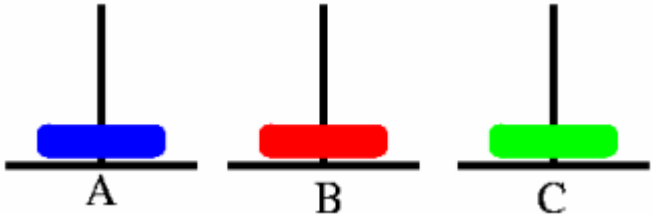
Step 3: Move A → C



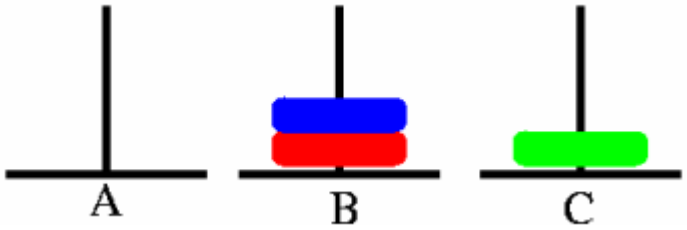
Step 4: Move B→ A



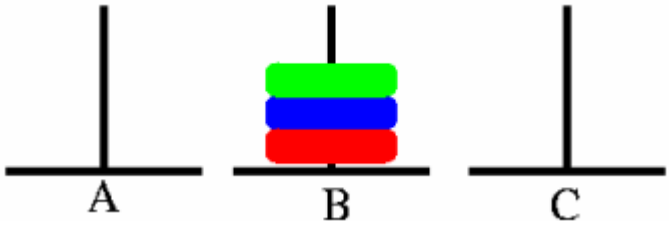
Step 5: Move C → B



Step 6: Move A → B



Step 7: Move C→ B



VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	**1**

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthling.
3. Use standard Electrical symbols.
4. Don’t touch wire with wet hand.
5. Check the power supply before connection.

X Procedure

1. Open the Python 3.0 software in the computer
2. Write the code for the given problem
3. Execute the code
4. Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Identification of initial state and goal state for a given 4 pegs problem

Python code	Comments

`num_disks = 4`
 	
`initial_state = ([i for i in range(num_disks, 0, -1)], [], [], [])`
 	
`goal_state = ([], [], [], [i for i in range(num_disks, 0, -1)])`
 	
`print("Initial State:", initial_state)`
`print("Goal State:", goal_state)`
	`# Number of disks`
	
	`# Initial State: All disks on the first peg`
	
	`# Goal State: All disks on the third peg`
	
	`# Display the states`

Problem statement for the students:

Identification of initial state and goal state for a given 3 pegs problem

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is the initial state for a Tower of Hanoi problem with 3 disks?
2. What is the goal state for a Tower of Hanoi problem with 3 disks?
3. How many pegs and disks are used in the Tower of Hanoi problem?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220
3. https://stackoverflow.com/questions/77891274/can-we-find-initial-peg-of-tower-of-hanoi-problem-from-middle-states

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.2: Identification of initial state and goal state for a given problem on chessboard

I Practical Significance

To familiarize the students with the initial state and goal state for a given problem

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Determine initial state and goal state for a given problem.

IV Laboratory Learning Outcome(s)

- Identify the initial state and goal state for the state space problem: Problem is to place 8 queens on a chessboard so that no two queens are in the same row,column or diagonal.
- Develop the flowchart for finding initial state and goal state for the state space problem to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal.

V Relevant Affective Domain related outcome(s)

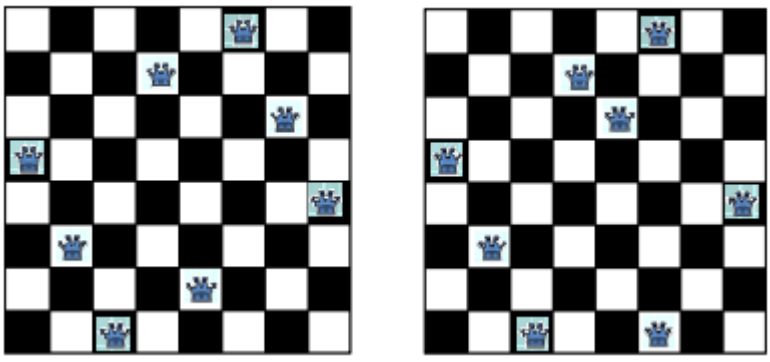
Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

The problem is to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal

The picture below on the left shows a solution of the 8-queens problem. The picture on the right is not a correct solution, because some of the queens are attacking each other.

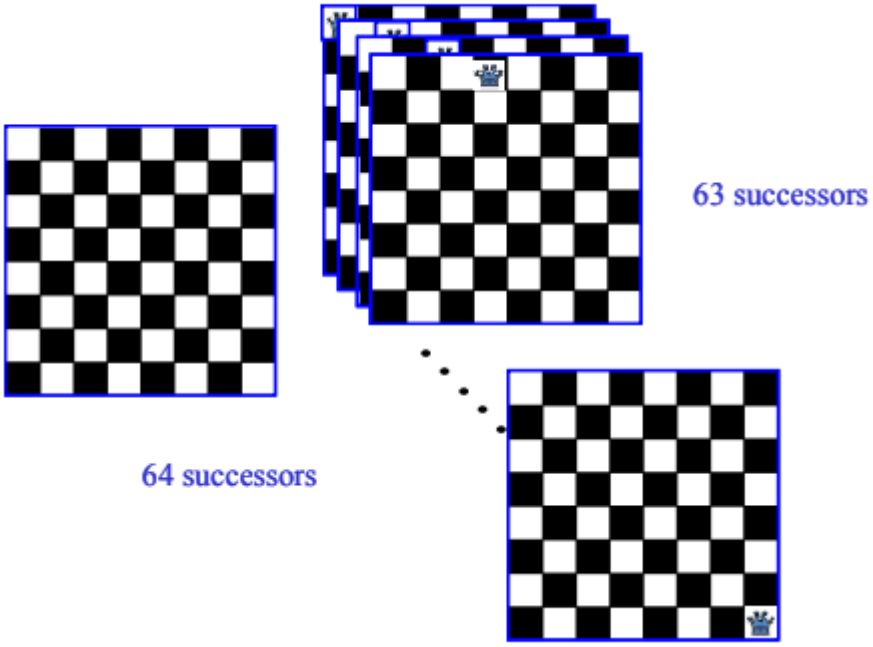


How do we formulate this in terms of a state space search problem? The problem formulation involves deciding the representation of the states, selecting the initial state representation, the description of the operators, and the successor states. We will now show that we can formulate the search problem in several different ways for this problem.

N queens problem formulation 1

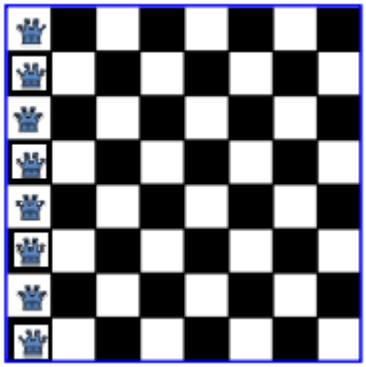
• States: Any arrangement of 0 to 8 queens on the board
• Initial state: 0 queens on the board
• Successor function: Add a queen in any square

• Goal test: 8 queens on the board, none are attacked



N queens problem formulation 2

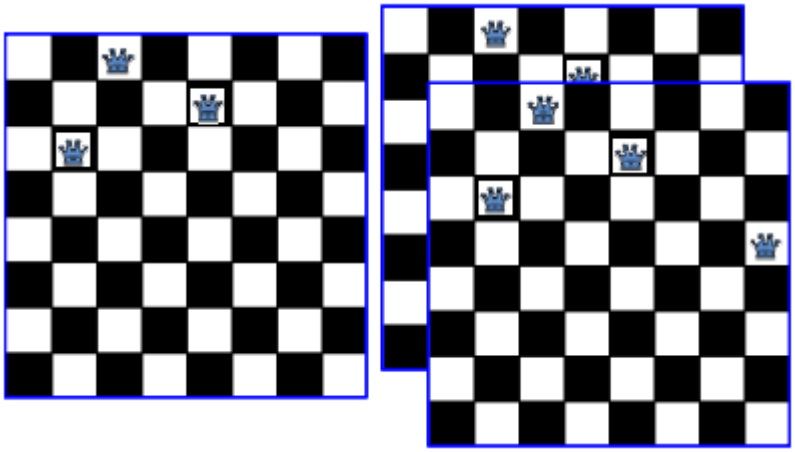
• States: Any arrangement of 8 queens on the board
• Initial state: All queens are at column 1
• Successor function: Change the position of any one queen
• Goal test: 8 queens on the board, none are attacked



If we consider moving the queen at column 1, it may move to any of the seven remaining columns.

N queens problem formulation 3

• States: Any arrangement of k queens in the first k rows such that none are attacked
• Initial state: 0 queens on the board
• Successor function: Add a queen to the (k+1)th row so that none are attacked.
• Goal test : 8 queens on the board, none are attacked.



VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthing.
3. Use standard Electrical symbols.
4. Don‟t touch wire with wet hand.
5. Check the power supply before connection

X Procedure

1. Open the Python 3.0 software in the computer
2. Write the code for the given problem
3. Execute the code
4. Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Identification of initial state and goal state for a given problem on chess board, The problem is to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal

Python code	**Comments**

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is the 8-Queens problem?
2. What is the purpose of the is safe function in the program?
3. What algorithm is used to solve the 8-Queens problem?
4. How does the program backtrack when it encounters a conflict?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220
3. https://www.geeksforgeeks.org/state-space-search-in-ai/

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.3: * Implementation of breadth first search algorithm

I Practical Significance

To familiarize the students with the implementation of breadth first search algorithm

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts

III Course Level Learning Outcome(s)

Use relevant AI search strategies for problem solving.

IV Laboratory Learning Outcome(s)

Write a program to implement breadth first search algorithm (Uninformed) using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

- **Graph Representation**:
  - The graph is represented as an **adjacency list** (dictionary in Python).
  - Each key is a node, and its value is a list of adjacent nodes.
- **Queue:**
  - A deque (double-ended queue) is used to manage the nodes for BFS traversal.
- **Visited Set**:
  - A set is used to keep track of nodes that have already been visited to avoid processing them multiple times.
- **BFS Process**:
  - The algorithm starts at the start node.
  - It processes the current node, adds its unvisited neighbors to the queue, and marks them as visited.
  - The process repeats until the queue is empty.

VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthing.
3. Use standard Electrical symbols.
4. Don‟t touch wire with wet hand.
5. Check the power supply before connection

X Procedure

1. Open the Python 3.0 software in the computer
2. Write the code for the given problem
3. Execute the code
4. Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of breadth first search algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is Breadth-First Search (BFS)?
2. How does the BFS algorithm work?
3. What is the data structure used in BFS to track nodes to be processed?
4. What is the purpose of the visited set in BFS?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220
3. https://www.geeksforgeeks.org/breadth-first-search-or-bfs-for-a-graph/?ref=lbp

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.4: Implementation of depth first search algorithm

I Practical Significance

To familiarize the students with the implementation of depth first search algorithm

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts

III Course Level Learning Outcome(s)

Use relevant AI search strategies for problem solving.

IV Laboratory Learning Outcome(s)

Write a program to implement depth first search algorithm (Uninformed) using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

A basic graph traversal algorithm for examining a graph's nodes and edges is called Depth-First Search (DFS). It begins from a chosen node, or the root in the case of trees, and travels as far as it can along each branch before turning around. Numerous graph-based issues, including pathfinding, cycle detection, topological sorting, and maze-solving, are addressed by DFS.

The DFS Algorithm steps are as follows:

- Begin at the root node (or any specific node).
- Put a visitation mark on the node.
- Visit each of the current node's unexplored neighbors.
- Mark each unvisited neighbor as visited by repeating the procedure.
- Return to the preceding node and repeat the procedure for its remaining unvisited neighbors if there are no more unvisited neighbors.
- When every reachable node has been reached, end the process.

VII Circuit diagram / Layout of Laboratory

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthling.
3. Use standard Electrical symbols.
4. Don’t touch wire with wet hand.
5. Check the power supply before connection

X Procedure

1. Open the Python 3.0 software in the computer
2. Write the code for the given problem
3. Execute the code
4. Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of depth first search algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is Depth-First Search (DFS)?
2. How does DFS work?
3. What data structure is commonly used in DFS to keep track of nodes to be visited?
4. What is the difference between DFS and BFS (Breadth-First Search)?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220
3. https://www.geeksforgeeks.org/depth-first-search-or-dfs-for-a-graph/

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.5: * Implementation of forward chaining algorithm

I Practical Significance

To familiarize the students with the Implementation of A* search algorithm.

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Use relevant AI search strategies for problem solving.

IV Laboratory Learning Outcome(s)

Write a program to implement A* search algorithm for solving the given problem using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

One of the most widely used and potent search algorithms in computer science and artificial intelligence (AI) is the A (A-star) search algorithm. In a graph, which could be a maze, a road network, or any other problem that can be expressed as a pathfinding or state-space search problem, it is used to determine the shortest path between a start node and a goal node.

Dijkstra's method is extended by the A* search algorithm, which adds a heuristic to help direct the search more effectively. When the heuristic is consistent and acceptable (i.e., it never overestimates the true cost to achieve the goal), it is both optimal and complete. process of deduction, in which the system uses rules to infer new information based on known data.

VII Circuit diagram / Layout of Laboratory

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthing.
3. Use standard Electrical symbols.
4. Don‟t touch wire with wet hand.
5. Check the power supply before connection

X Procedure

1. Open the Python 3.0 software in the computer
2. Write the code for the given problem
3. Execute the code

4. Verify the result

XI Resources Used

Sr.No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of A* search algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What are the key components of the A* algorithm?
2. What is a heuristic in the context of A*?
3. How does the A* algorithm work?

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.6: * Implementation of travelling salesman problem

I Practical Significance

To familiarize the students with the implementation of travelling salesman problem.

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Use relevant AI search strategies for problem solving.

IV Laboratory Learning Outcome(s)

Write a program to implement travelling salesman problem for solving the given problem using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

The Travelling Salesman Problem (TSP) is a well-known combinatorial optimization problem in which a salesman is given a set of cities and must determine the shortest possible route that visits each city exactly once and returns to the starting point. The problem is NP-hard, meaning that no polynomial-time solution is known for solving it optimally in all cases. However, there are various methods to approximate or solve it optimally in certain situations.

The **Travelling Salesman Problem (TSP)** is a well-known NP-hard problem where the objective is to find the shortest possible route that visits each city exactly once and returns to the starting city. This problem is a typical **combinatorial optimization problem**. While finding an optimal solution is computationally expensive for large numbers of cities, **local search algorithms** can be used to find good approximate solutions efficiently.

VII Circuit diagram / Layout of Laboratory

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

6. Verify power ratings.
7. Ensure proper earthing.
8. Use standard Electrical symbols.
9. Don‟t touch wire with wet hand.
10. Check the power supply before connection

X Procedure

5. Open the Python 3.0 software in the computer
6. Write the code for the given problem

7. Execute the code
8. Verify the result

XI Resources Used

Sr.No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of travelling salesman problem

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is the Travelling Salesman Problem (TSP)?
2. What are some methods for solving TSP?
3. What are some real-world applications of TSP?

[Space for Answers]

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XVIII References/Suggestions for further reading

3. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
4. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.7: *Implementation of forward chaining algorithm

I Practical Significance

To familiarize the students with the implementation of forward chaining algorithm.

II Industry/Employer Expected Outcome(s)

Apply the principles of Robotics to automate various industries

III Course Level Learning Outcome(s)

Interpret different types of knowledge and reasoning techniques used in AI.

IV Laboratory Learning Outcome(s)

Using first order logic write a program to implement forward chaining algorithm using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Forward Chaining is a reasoning algorithm used in **Artificial Intelligence** (AI) for i**nference** in rule-based systems. It is one of the two primary types of inference used in expert systems, the other being **Backward Chaining**.Forward chaining works by starting with a set of known facts and using inference rules to derive new facts, continuously adding them to the knowledge base until a goal or conclusion is reached.

The knowledge base for forward chaining is made up of a collection of rules and facts (or propositions).

Facts: At the start of the procedure, these are known to be accurate.

Rules: These are "IF condition THEN conclusion" conditional statements. The conclusion (or action) of a rule is derived as a new fact when its criteria (premises) are met.

Mechanism of Inference:

With forward chaining, the system begins with known facts and employs rules to infer new facts through a process of deduction.

The system adds the new fact to the knowledge base by choosing the fact that may be inferred from the rules and facts that already exist.

VII Circuit diagram / Layout of Laboratory

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

11. Verify power ratings.
12. Ensure proper earthing.
13. Use standard Electrical symbols.
14. Don‟t touch wire with wet hand.
15. Check the power supply before connection

X Procedure

9. Open the Python 3.0 software in the computer
10. Write the code for the given problem
11. Execute the code
12. Verify the result

XI Resources Used

Sr.No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of forward chaining algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

4. What is Forward Chaining in Artificial Intelligence?.
5. How does the Forward Chaining algorithm work?
6. What is the main difference between Forward Chaining and Backward Chaining?

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.8: Implementation of backward chaining algorithm

I Practical Significance

To familiarize the students with the concept of implementation of backward chaining algorithm

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts

III Course Level Learning Outcome(s)

Interpret different types of knowledge and reasoning techniques used in AI.

IV Laboratory Learning Outcome(s)

Using first order logic write a program to implement backward chaining algorithm using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Backward Chaining is a reasoning technique commonly used in artificial intelligence (AI), particularly in expert systems and rule-based systems. The method works by starting with a goal (hypothesis) and working backward to determine if there are facts or known rules that support the goal. It is the opposite of forward chaining, which starts with known facts and works forward to reach a conclusion.Circuit diagram Layout of Laboratory

Steps in Backward Chaining:

1. **Start with the Goal**:
   Identify the goal or query you want to prove.
2. **Search for Rules**:
   Look for rules that can produce the goal as their conclusion (the "then" part).
3. **Verify Conditions**:
   For each rule found, check whether the conditions (the "if" part) are true:
   - If the conditions are facts, verify them directly.
   - If the conditions are not facts, treat them as subgoals and repeat the process.
4. **Repeat Until Proven or Disproven**:
   Continue this process until the goal is either:
   - Proven true (all supporting facts and subgoals are satisfied), or
   - Disproven (no supporting facts or rules are available).

VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	**-**	**1**

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthling.
3) Use standard Electrical symbols.
4) Don’t touch wire with wet hand.
5) Check the power supply before connection

X Procedure

1) Open the Python 3.0 software in the computer
2) Write the code for the given problem
3) Execute the code
4) Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of backward chaining algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is backward chaining?
2. How does backward chaining differ from forward chaining?
3. What are the main steps in implementing backward chaining?

[Space for Answers]

XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.9: Implementation of forward reasoning

I Practical Significance

To familiarize the students with the concept of Implementation of forward reasoning.

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Interpret different types of knowledge and reasoning techniques used in AI.

IV Laboratory Learning Outcome(s)

Write a program to implement forward reasoning using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Forward reasoning, also known as forward chaining, is a data-driven approach to reasoning used in artificial intelligence (AI) and rule-based systems. It begins with known facts and applies inference rules to derive new facts or conclusions, continuing this process until a desired goal or outcome is reached.

Key Concepts of Forward Reasoning:

- Data-Driven Reasoning:
  Forward reasoning starts from a set of facts or initial conditions and applies inference rules to derive conclusions incrementally. It is called data-driven because it relies on available data to move toward conclusions.
- Rule-Based Systems:
  The knowledge base is represented as a set of if-then rules:
  - If condition(s), then conclusion(s).
  - Rules are applied iteratively to deduce new facts.
- Inference Engine:
  An inference engine drives the reasoning process by:
  - Matching facts to the conditions of rules.
  - Applying rules to generate new facts.
  - Repeating the process until no more rules can be applied or a specific goal is reached.
- Termination:
  Forward reasoning stops when:
  - A specific goal or condition is satisfied, or
  - No more rules can be applied.

VII Actual Circuit diagram used in a laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	**-**	**1**

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthling.
3) Use standard Electrical symbols.
4) Don’t touch wire with wet hand.
5) Check the power supply before connection.

X Procedure

1) Open the Python 3.0 software in the computer
2) Write the code for the given problem
3) Execute the code
4) Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
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XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of forward reasoning algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is forward reasoning?
2. How does forward reasoning differ from backward reasoning?
3. What are the main components of forward reasoning?
4. What are the key steps in forward reasoning?

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.10: * Implementation of backward reasoning

I Practical Significance

To familiarize the students with the concept of implementation of backward reasoning

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Interpret different types of knowledge and reasoning techniques used in AI.

IV Laboratory Learning Outcome(s)

Write a program to implement backward reasoning using python

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Backward reasoning, also known as **goal-driven reasoning**, is a logical approach where reasoning starts from a specific goal or conclusion and works backward to determine what facts or conditions must be true for the goal to be achieved. This method is widely used in problem-solving, artificial intelligence (AI), expert systems, and automated theorem proving.

Key Concepts in Backward Reasoning

Goal-Driven Approach:

- Backward reasoning starts with a goal or hypothesis.
- It identifies the conditions or premises required to achieve this goal.
- Each condition is recursively analyzed until it connects to known facts or is proven true.

Deductive Reasoning:

- Backward reasoning is based on deductive logic.
- Given a rule A→BA \right arrow BA→B (if A then B), and the goal BBB, backward reasoning checks whether AAA holds true.

Recursive Decomposition:

- Goals are broken down into sub goals.
- Each sub goal is treated as a new goal until it can be linked to known facts or base conditions.

VII Circuit diagram Layout of Laboratory

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	**-**	**1**

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthling.
3) Use standard Electrical symbols.
4) Don't touch wire with wet hand.
5) Check the power supply before connection

X Procedure

1) Open the Python 3.0 software in the computer
2) Write the code for the given problem
3) Execute the code
4) Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Implementation of backward reasoning algorithm

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is backward reasoning?
2. How does backward reasoning work?
3. What are the key components of implementing backward reasoning?
4. List advantages of backward reasoning?

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.11: Implementation of Bayesian reasoning

I Practical Significance

To familiarize the students with the concept of implementation of Bayesian reasoning

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Interpret different types of knowledge and reasoning techniques used in AI.

IV Laboratory Learning Outcome(s)

Write a program to implement Bayesian reasoning using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Bayesian reasoning is a statistical method based on Bayes' Theorem, which updates the probability estimate of an event as new evidence becomes available. It is widely used in areas such as medical diagnosis, spam filtering, and machine learning.

Bayes' Theorem Formula

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

Where:

- P(A|B): Posterior probability (Probability of A given B).
- P(B|A): Likelihood (Probability of B given A).
- (A): Prior probability (Initial probability of A).
- P(B): Evidence (Total probability of B).

Steps to Implement Bayesian Reasoning in Python

- Define the Problem
- Compute Prior Probabilities
- Calculate Likelihood (P(B| A)P(B|A)P(B| A))
- Determine the probability of the evidence given the event.
- Compute Total Probability (P(B)P(B)P(B))
- Apply Bayes' Theorem:
- Automate with Python Code:

VII Circuit diagram Layout of Laboratory

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Desktop PC loaded with Python 3.0	-	1

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthing.
3) Check the power supply before connection.

X Procedure

1. Open the open source software Scilab in the computer
2. Write the code for the given problem
3. Execute the code
4. Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:
Implementation of Bayesian reasoning

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is Bayes' Theorem, and what are its components?
2. How does Bayesian reasoning differ from frequentist methods?
3. Why is the prior probability important in Bayesian reasoning?.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.12: Implementation of data extraction

I Practical Significance

To familiarize the students with the implementation of data extraction.

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Apply the learning methods adopted in AI.

IV Laboratory Learning Outcome(s)

Write a program to read the data from a given dataset into python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Steps to read csv and excel file in Jupyter notebook inside pandas.

- Data is present in two files, first is a csv file named data.csv and second is an excel file named data. excel.
- First import library first i.e. pandas.
- Let us read first csv file.csv file can be read in pandas using read_csv function and file we are going to read is data.csv
- First of all we create a variable i.e df (which will store the data frame).We will call the read_csv function inside the pandas package.
- We need to supply the name of the file that we want to read with its full path where it is stored.
- Now the file has been read. To confirm that particular file only read, we can check the first few rows using the **head** function.
- This confirms that the data.csv file has been read properly.
- To read an excel file which is very much similar to read csv file. Only difference is instead of read_csv function, we have to use read_excel function.

VII Actual Circuit diagram used in laboratory with related equipment rating-

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Computer System	Computer i3/i5, 64 bit Windows 10 , 3 GB RAM	**1**
2	Python Compiler	Anaconda/Google colab	

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthling.
3) Use standard Electrical symbols.

4) Don't touch wire with wet hand.
5) Check the power supply before connection.

X Procedure

1) Open the Python 3.0 software in the computer
2) Write the code for the given problem
3) Execute the code
4) Verify the result

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:
Implementation of data extraction

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. List functions of Pandas.
2. Explain the Steps to read csv and excel file in Jupyter notebook inside pandas.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.13: *Develop a program to split dataset

I Practical Significance

To familiarize the students to develop a program to split dataset

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Apply the learning methods adopted in AI.

IV Laboratory Learning Outcome(s)

Write a program to split available dataset into training and test set using python.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Splitting Dataset into training and test set

- The data should ideally be divided into 3 sets – namely, train, test, and holdout cross-validation or development (dev) set.
- Train Set:
  The train set would contain the data which will be fed into the model. In simple terms, our model would learn from this data.
- Validation set/Dev Set:
  The development set is used to validate the trained model. This is the most important setting as it will form the basis of our model evaluation. If the difference between error on the training set and error on the dev set is huge, it means the model as high variance and hence, a case of over-fitting.
- Test Set:
  The test set contains the data on which we test the trained and validated model. It tells us how efficient our overall model is.
- The size of the train, dev, and test sets remains one of the vital topics of discussion. Though for general Machine Learning problems a train/dev/test set ratio of 80/20/20 is acceptable.

VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Computer System	Computer i3/i5,64 bit Windows 10 , 3 GB RAM	1
2	Python Compiler	Anaconda/Google colab	

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthling.
3) Use standard Electrical symbols.
4) Don't touch wire with wet hand.
5) Check the power supply before connection.

X Procedure

1) Open the Python 3.0 software in the computer
2) Write the code for the given problem
3) Execute the code
4) Verify the result

1.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculations (use blank sheet provided if space not sufficient)

Problem statement for the students:

Develop a program to split dataset

Python code	Comments

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. How would you implement stratified sampling to ensure class proportions are maintained?
2. How can you split a dataset into training, testing, and validation sets in a single step?
3. Implement k-fold cross-validation to split a dataset into multiple training and testing sets.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://nptel.ac.in/courses/106102220

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.14: * Implementation of motion commands for robot using simulator

I Practical Significance

To familiarize the students with the concept of implementation of motion commands for robot using simulator.

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Apply the principles of AI in robotics.

IV Laboratory Learning Outcome(s)

Simulate different types of motion commands for robot.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

Robots rely on different motion commands depending on the application and the type of robot. These commands control how the robot moves in its workspace, either in joint space, Cartesian space, or along predefined trajectories. Below are common types of motion commands and their uses:

1. Joint Space Motion Commands

   Control the robot by specifying movements for each joint individually.

   - Point-to-Point (P2P) Motion
     Moves the robot's joints directly to target positions without considering the end-effector's path.
   - Linear Interpolation in Joint Space
     Each joint moves at a constant velocity to reach the target position simultaneously.
     Ensures synchronized joint motion.
   - Polynomial Trajectory
     Uses cubic or quintic polynomials to define smooth trajectories for each joint.
     Ensures smooth acceleration and deceleration.

2. Cartesian Space Motion Commands

   Directly control the robot's end-effector in Cartesian coordinates.

   - Linear Motion
     Moves the end-effector in a straight line in Cartesian space.
     Requires inverse kinematics (IK) to calculate joint angles.
   - Circular Motion
     Moves the end-effector along a circular or elliptical arc.
     Often used in tasks like welding or painting.
   - Spiral Motion
     Used for tasks like drilling or polishing, where the end-effector spirals inward or outward.

3. Mobile Robot Motion Commands

- Forward/Backward Motion
  Moves the robot in a straight line.
- Rotation
  Rotates the robot about its center.
- Arc Motion
  Combines linear and angular velocities to follow a curved path.
- Omnidirectional Motion
  For robots with omnidirectional wheels, allowing movement in any direction.
- Predefined Path Motion Commands
  These commands follow a predefined trajectory, useful for specific tasks.

VII Actual Circuit diagram used in a laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Robotics simulation software : Robodk/RT Toolbox3 / Robo analyzer /Dobot magician or any other simulation software		
2	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 10)		
3	Python Interpreter / IDE		
4	Robot structure with 4 linkages	**–**	**1**
5	Drawing Tool (Pen and Holder)	**–**	**1**

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthing.
3. Use standard Electrical symbols.
4. Don’t touch wire with a wet hand.
5. Check the power supply before connection.

X Procedure

1. One can determine the current position.
2. Set the location via., computer interface (software).
3. Later, the current position is assessed.
4. Further, motion is provided along the vertical direction (Z-axis).
5. Next displacement of the tool is along the X-Axis (in Horizontal Plane).
6. Then in next step, motion is provided along Y-Axis (in Vertical Plane).
7. After execution of this step the tool is retrieved back to its original vertical plane (height).
8. Later by using the interface, ‘Jump’ command is used to move to next position.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations (use blank sheet provided if space not sufficient)

Code :

Code	Comments

XIV Result(s)

Paste the picture of path acquired at the output with coordinates after you have coded for the robot.

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What simulator will you use (e.g., RoboAnalyzer, Gazebo, Webots)?
2. What programming languages or APIs are compatible with the simulator?
3. Are there pre-built libraries or plugins for motion planning and control in the simulator?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://robodk.com/download
2. https://www.youtube.com/watch?v=v7Vna4UF2AA

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.15: Implementation of end effector command for a given robot

I Practical Significance

To familiarize the students about implementation of end effector command for a given robot

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts.

III Course Level Learning Outcome(s)

Apply the principles of AI in robotics.

IV Laboratory Learning Outcome(s)

Simulate different end effector command for given Robot.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

The Concept of End-Effectors:

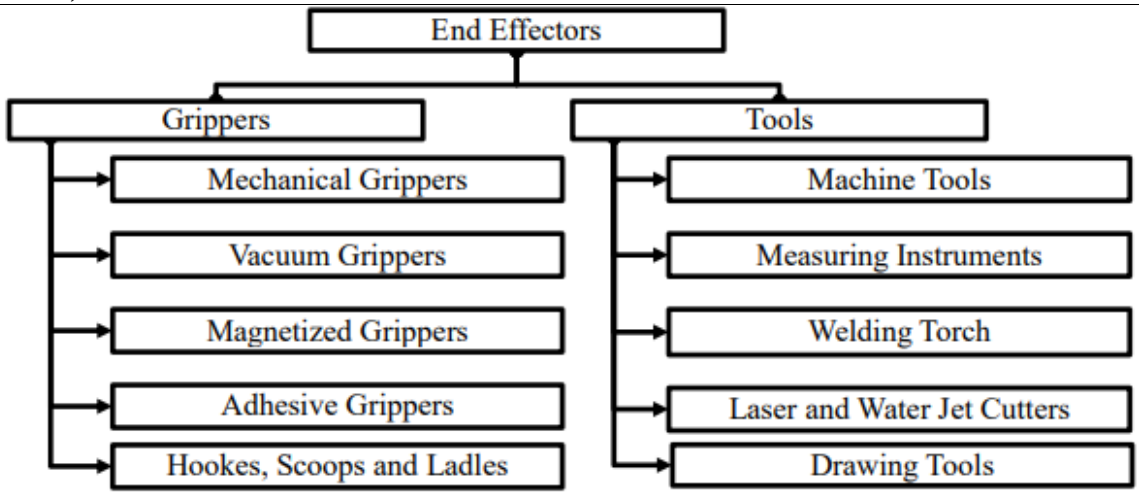
End Effector -

It is the Gripper or end-of-arm tooling attached to the wrist of manipulator to accomplish the desired task.

Some general aspects of end effectors -

- End effectors range from commercial devices such as pneumatic gripers to special tools (maybe used for arc welding purposes, spray painting, etc.).
- Due to diverse applications and end effectors are usually customized for specific applications and they can have additional components such as force measuring devices as well as mechanical linkages for different positions.
- The end-of-arm tool not only has an interface with the robot but also it should not interfere with any other peripheral devices in work space.
- End effectors along with gripping purpose may include sensors to determine if a part is present or absent. This addition of a sensor makes gripper, a relatively intelligent device.
- If end effectors are made to be more sophisticated then it can have features such as servo-controlled access with force control and sensors to measure the dimensions or the weight of an object.

  Types of End EffectorsThese are classified as two major categories namely gripper and tools.The grippers can be classified as "Part Handling Grippers, Tool Handling Grippers, and Specialized Grippers".
- Part Handling Grippers–These are used to grasp and hold objects and also to transport goods from one position to another. For example- Machine Loading and Unloading, Picking parts from conveyor.
- Tool Handling Grippers –These are used to hold tools like welding gun or spray-painting gun to perform a specific task like deburring tool.



VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Robotics simulation software : Robodk/RT Toolbox3 / Robo analyzer /Dobot magician or any other simulation software		
2	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 10)		
3	Python Interpreter / IDE		
4	Robot structure with 4 linkages	**–**	**1**
5	Drawing Tool (Pen and Holder)	**–**	**1**

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthing.
3) Use standard Electrical symbols.
4) Don’t touch wire with wet hand.
5) Check the power supply before connection.

X Procedure

1. Define the Robot Model
2. Configure the Simulation Environment
3. Program the End-Effector Command.
4. Run the Simulation.
5. Analyze and Refine

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations (use blank sheet provided if space not sufficient)

Code :

Code	Comments

XIV Result(s)

Paste the picture of path acquired at the output with coordinates after you have coded for the robot.

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What does an end-effector command mean in the context of simulation?
2. How do I visualize the robot's movement?

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XVIII References/Suggestions for further reading

1. https://robodk.com/download
2. https://www.youtube.com/watch?v=v7Vna4UF2AA

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.16 Execution of robotic operations by bridging robot vision systems

I Practical Significance

To familiarize the students about the execution of robotic operations by bridging robot vision systems

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts

III Course Level Learning Outcome(s)

Apply the principles of AI in robotics.

IV Laboratory Learning Outcome(s)

Simulate robot operation using machine vision system.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

The integration of robot vision systems into robotic operations allows robots to perceive, interpret, and interact with their environment autonomously. This combination enables robots to execute tasks more flexibly and accurately by using sensory data to guide their actions.

- Role of Vision in Robotics

Robot vision systems emulate human vision, enabling robots to:

  - Recognize Objects: Identify and classify objects in the environment.
  - Estimate Pose: Determine the position and orientation of objects.
  - Navigate: Plan paths and avoid obstacles.
  - Perform Quality Inspection: Detect defects or deviations in products.
  - Enable Interaction: Facilitate precise manipulation and assembly tasks.

- Workflow of Bridging Robot Vision with Robotic Operations

  Step 1: Perception

  Image Acquisition: The robot captures images or videos of its environment using cameras.

  Preprocessing: The raw data is filtered to remove noise and enhance features.

  Object Detection and Recognition: Algorithms identify and classify objects of interest.

  Step 2: Interpretation

  Pose Estimation: Determine the location and orientation of objects in 3D space.

  Scene Understanding: Identify relationships between objects and recognize patterns or constraints.

  Step 3: Planning

  Task Planning: Use the interpreted data to generate a task plan (e.g., pick-and-place operations, path planning).

  Motion Planning: Calculate a collision-free trajectory for the robot.

  Step 4: Execution

  The robotic system sends commands to actuators based on the planned actions, enabling it to manipulate objects, navigate, or inspect.

VII Actual Circuit diagram used in laboratory with related equipment rating
NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Robotics simulation software : Robodk/RT Toolbox3 / Robo analyzer /Dobot magician or any other simulation software		
2	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 10)		
3	Python Interpreter / IDE		
4	Robot structure with 4 linkages	**–**	**1**
5	Drawing Tool (Pen and Holder)	**–**	**1**

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthing.
3) Don't touch wire with wet hand.
4) Check the power supply before connection.

X Procedure

1. Define the Task Requirements.
2. Set Up the Vision System
3. Integrate Vision with the Robot
4. Preprocessing the Visual Data
5. Analyze and Interpret the Data
6. Execute Commands
7. Monitor and Validate

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations (use blank sheet provided if space not sufficient)

Code :

Code	Comments

XIV Result(s)

Paste the picture of path acquired at the output with coordinates after you have coded for the robot.

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is the purpose of integrating vision systems into robotic operations?
2. How does a vision system enhance the precision and flexibility of a robot?
3. What are the key differences between 2D and 3D vision systems in robotic applications?

[Space for Answers]

XVIII References/Suggestions for further reading

1. https://robodk.com/download
2. https://www.youtube.com/watch?v=v7Vna4UF2AA

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.17 Implementation of specific path movement of robot

I Practical Significance

To familiarize the students about the implementation of specific path movement of robot

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts

III Course Level Learning Outcome(s)

Apply the principles of AI in robotics.

IV Laboratory Learning Outcome(s)

Write a program for specific path movement of robot.

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

It integrates kinematics, path planning, control systems, and sensor feedback. Kinematics defines the motion relationship between the robot's structure and its trajectory. Path planning algorithms, such as A* or RRT, compute optimal routes while avoiding obstacles, and trajectory generation ensures smooth, continuous motion. Control systems, like PID or Model Predictive Control, adjust the robot's actuators to follow the planned path precisely. Sensor feedback from encoders, IMUs, cameras, or LiDAR aids in real-time localization, ensuring the robot stays on course and adapts to environmental changes. This comprehensive approach enables accurate and efficient robot navigation along a predefined path.

VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Robotics simulation software : Robodk/RT Toolbox3 / Robo analyzer /Dobot magician or any other simulation software		
2	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 10)		
3	Python Interpreter / IDE		
4	Robot structure with 4 linkages	**–**	**1**
5	Drawing Tool (Pen and Holder)	**–**	**1**

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthing.
3) Don’t touch wire with wet hand.
4) Check the power supply before connection.

X Procedure

1. Define Objectives.
2. Choose a Simulation Software
3. Set Up the Robot Model
4. Environment Design
5. Path Planning
6. Control System Implementation
7. Localization and Feedback Integration
8. Simulate and Visualize

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations (use blank sheet provided if space not sufficient)

Code :

Code	Comments

XIV Result(s)

Paste the picture of path acquired at the output with coordinates after you have coded for the robot.

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is the purpose of implementing specific path movement in a robot?
2. Which simulation software can be used for implementing robot path movement?
3. What are the key components of a robot model required for path simulation?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://robodk.com/download
2. https://www.youtube.com/watch?v=v7Vna4UF2AA

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.18 Implementation of painting operation with AI based robot

I Practical Significance

To familiarize the students about the implementation of painting operation with AI based robot

II Industry/Employer Expected Outcome(s)

Simulate automated robotic systems through artificial intelligence concepts

III Course Level Learning Outcome(s)

Apply the principles of AI in robotics.

IV Laboratory Learning Outcome(s)

Write a program for painting operation with AI based Robot..

V Relevant Affective Domain related outcome(s)

Follow ethical practices

Handle tools and equipment carefully.

VI Relevant Theoretical Background

The implementation of painting operations with an AI-based robot using simulation software involves integrating robotics, computer vision, AI, and simulation tools. The robot's kinematics are modeled to ensure precise motion for uniform paint application on complex surfaces. Simulation software provides a virtual environment to design the robot and test painting scenarios. AI algorithms, including deep learning, optimize the robot's path planning, paint coverage, and spraying parameters based on surface texture and shape. Computer vision systems simulate the robot's ability to identify and adapt to target surfaces and detect irregularities. Feedback from virtual sensors in the simulation ensures real-time error correction and uniform paint distribution. This approach enables thorough testing and optimization of the painting process before real-world deployment, ensuring high efficiency and quality.

VII Actual Circuit diagram used in laboratory with related equipment rating

NA

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Robotics simulation software : Robodk/RT Toolbox3 / Robo analyzer /Dobot magician or any other simulation software		
2	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 10)		
3	Python Interpreter / IDE		
4	Robot structure with 4 linkages	**–**	**1**
5	Drawing Tool (Pen and Holder)	**–**	**1**

IX Precautions to be followed

1. Verify power ratings.
2. Ensure proper earthing.
3. Don’t touch wire with wet hand.
4. Check the power supply before connection.

X Procedure

1. Define Objectives
2. Choose Suitable Simulation Software
3. Design the Robot Model
4. Simulate the Painting Environment
5. Develop Motion Planning
6. Integrate AI and Computer Vision
7. Control System Implementation
8. Simulate Painting Dynamics

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations (use blank sheet provided if space not sufficient)

Code :

Code	Comments

XIV Result(s)

Paste the picture of path acquired at the output with coordinates after you have coded for the robot.

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What simulation software is most commonly used for AI-based robotic painting operations?
2. How do AI algorithms improve the efficiency of robot painting operations?
3. What role does computer vision play in the implementation of painting operations with AI-based robots?

[Space for Answers]

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Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	