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| Lesson Plan No. 01 | Course Name: Discrete Mathematics Topic: Basic Principles of Counting | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: 1. Explain the two fundamental principles of counting: the Addition Principle and the Multiplication Principle. 2. Apply these principles to solve basic counting problems. 3. Recognize real-life applications of counting principles. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <p>1. Introduction (10 minutes)</p> <p>Engage: Pose a real-world scenario and encourage students to brainstorm their answers.</p> <p>Discuss: Introduce the topic by explaining that how many real world problems are solved using the Basic Principles of Counting.</p> <p>Objective Overview: Clearly outline the objectives of the lesson.</p> <p>2. Content Delivery (30 minutes)</p> <ul style="list-style-type: none"> Addition Principle (10 minutes): Define, give examples and practice problems. Multiplication Principle (10 minutes): Define, give examples and practice problems. Combined Problems (10 minutes): Discuss how both principles can be applied together in more complex problems. <p>3. Active Engagement (5 minutes)</p> <p>Pair Activity: Give each pair a set of 2-3 counting problems combining the Addition and Multiplication Principles to solve together.</p> <p>Discuss solutions briefly as a class.</p> |
| Closure | <ol style="list-style-type: none"> Recap: Summarize the Addition and Multiplication Principles with examples. Real-Life Applications: Highlight scenarios where these principles are useful (e.g., scheduling, password security). Question and Answer: Address any remaining questions. |
| Evaluation | <ol style="list-style-type: none"> Homework Assignment: Provide 5 problems involving counting principles, including real-life applications. Quiz (Next Session): Include a short quiz on counting principles to assess understanding. |



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| Lesson Plan No. 02 | Course Name: Discrete Mathematics Topic: Pigeonhole Principle | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Understand and state the Pigeonhole Principle. 2. Apply the principle to solve problems in discrete mathematics. 3. Identify real-world scenarios where the Pigeonhole Principle can be applied. |
| Teaching Aids (if any) | a. ICT |
| Teaching Development | <p style="text-align: center;">1. Introduction (10 minutes)</p> <p>Engage: Start with a question and allow students to think and respond. Define and Explain the Pigeonhole Principle. Real-Life Analogy: Use a simple analogy.</p> <p style="text-align: center;">2. Content Delivery (30 minutes)</p> <p>Basic Principle (10 minutes)</p> <ul style="list-style-type: none"> • Statement • Illustrative Example • Practice Problems • Discuss and derive solutions collaboratively. <p>Generalized Principle (15 minutes)</p> <ul style="list-style-type: none"> • Statement • Illustrative Example • Practice Problems • Solve interactively as a class. <p>Active Engagement (5 minutes)</p> <ul style="list-style-type: none"> • Small Group Activity: Provide each group with a real-world application problem. • Groups solve and present their reasoning. |
| Closure | <p>Recap: Summarize the Pigeonhole Principle with the examples discussed.</p> <p>Highlight Applications: Mention applications in Computer science (hashing and data storage) and Probability and statistics.</p> <p>Final Question: Pose an open-ended question to the students like "Can you think of other scenarios where this principle applies?"</p> |
| Evaluation | <p>Class Participation: Monitor contributions during the group activity.</p> <p>Homework Assignment: Assign 5 problems, ranging from basic applications to advanced generalizations of the principle.</p> <p>Quiz (Next Session): Include a mix of theoretical and applied questions on the Pigeonhole Principle.</p> |



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| Lesson Plan No. 03 | Course Name: Discrete Mathematics Topic: Generating Functions | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define generating functions and understand their purpose in combinatorics. 2. Construct generating functions for basic sequences. 3. Use generating functions to solve recurrence relations. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Pose a problem: "How can we encode all terms of a sequence into a single mathematical expression that can be manipulated algebraically?"</p> <p>Briefly discuss real-world applications of generating functions in computer science. Define generating functions and state that the lesson will focus on constructing, analyzing, and applying generating functions.</p> <p>Content Delivery (30 minutes)</p> <ul style="list-style-type: none"> • Constructing Generating Functions (10 minutes) • Using Generating Functions to Solve Recurrence Relations (10 minutes) • Applications to Counting Problems (10 minutes) <p>Active Engagement (5 minutes)</p> <p>Group Activity: Provide a sequence such as Fibonacci sequence, and ask groups to derive its generating function. Discuss how generating functions simplify recurrence relations for this sequence.</p> |
| Closure | <p>Recap: Summarize key points.</p> <p>Real-World Insight: Mention applications in algorithmic complexity and probability.</p> <p>Final Question: Ask students to think about how generating functions might be used in their fields of computer sciences.</p> |
| Evaluation | Monitor engagement during problem-solving and group discussion. Spend 5 minutes at the end of class to evaluate student assimilation of the lesson contents. |





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| Lesson Plan No. 04 | Course Name: Discrete Mathematics Topic: Recurrence relations | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define recurrence relations and understand their significance in mathematics and computer science. 2. Classify recurrence relations (linear, non-linear, homogeneous, non-homogeneous). 3. Solve simple recurrence relations using substitution and characteristic equation methods. 4. Apply recurrence relations to model and solve real-world problems. |
| Teaching Aids (if any) | a. ICT |
| Teaching Development | <p style="text-align: center;">1. Introduction (10 minutes)</p> <p>Engage: Pose a real world scenario and highlight the need for a systematic way to describe these problems. Define Recurrence Relations and give examples like Fibonacci sequence. Objective Overview: Outline what students will learn during the session.</p> <p style="text-align: center;">2. Content Delivery (30 minutes)</p> <ul style="list-style-type: none"> • Definition and Classification (10 minutes) • Examples for Discussion: • Solving Recurrence Relations (20 minutes) <p style="text-align: center;">3. Active Engagement (5 minutes)</p> <p>Group Activity: Provide a recurrence relation and ask groups to solve it. Groups present their solutions and discuss.</p> |
| Closure | <p>Recap: Summarize the key points. Real-World Applications: Highlight their use in: Algorithm analysis and Financial planning models. Final Thought: Ask students to think about how they could use recurrence relations in their fields of study.</p> |
| Evaluation | <ul style="list-style-type: none"> • Class Participation: Monitor engagement during group activity. • Homework Assignment: Provide few problems to solve. • Quiz (Next Session): Include problems requiring students to: Solve recurrence relations using characteristic equations. Derive and solve recurrence relations for a real-world situation. |



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| Lesson Plan No. 05 | Course Name: Discrete Mathematics Topic: Linear recurrence relations with constant coefficients | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: 1. Define linear recurrence relations with constant coefficients. 2. Solve homogeneous linear recurrence relations using the characteristic equation method. 3. Solve non-homogeneous linear recurrence relations using the method of undetermined coefficients. 4. Apply these methods to solve real-world problems. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <p style="text-align: center;">1. Introduction (10 minutes)</p> <ul style="list-style-type: none"> • Engage: Pose a real world scenario related to the topic and lead into defining recurrence relations as a mathematical tool for such scenarios. • Define Linear Recurrence Relations and give examples. • Objective Overview: Outline what students will learn, emphasizing practical applications. <p style="text-align: center;">2. Content Delivery (30 minutes)</p> <ul style="list-style-type: none"> • Homogeneous Linear Recurrence Relations (15 minutes): Definition and Examples. Solving recurrence relations using Characteristic Equation Method. • Non-Homogeneous Linear Recurrence Relations (15 minutes): Definition and Solution Structure, that is General solution = Solution of the homogeneous part + Particular solution. <ul style="list-style-type: none"> • Method of Undetermined Coefficients: <p style="text-align: center;">3. Active Engagement (5 minutes)</p> <p>Group Activity: Provide a recurrence relation for groups to solve collaboratively. Groups present their solutions and reasoning.</p> |
| Closure | <p>Recap: Summarize key points</p> <p>Real-World Applications like Algorithm analysis, Population dynamics, Financial planning models etc.</p> <p>Final Question: Ask students to think of other contexts where such relations might arise.</p> |
| Evaluation | <ul style="list-style-type: none"> • Class Participation: Monitor engagement during group activity and problem-solving discussions. • Homework Assignment: Assign problems related to the topic. |



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| Lesson Plan No. 06 | Course Name: Discrete Mathematics Topic: Fibonacci sequence | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none">1. Define the Fibonacci sequence and understand its recurrence relation.2. Derive and compute terms of the Fibonacci sequence.3. Analyze the properties and applications of the Fibonacci sequence in mathematics and the real world.4. Solve problems involving the Fibonacci sequence, including closed-form solutions (Binet's formula). |
| Teaching Aids (if any) | a. ICT |
| Teaching Development | <ol style="list-style-type: none">1. Introduction (10 minutes)<ul style="list-style-type: none">• Engage: Present a real-world example modeled by the Fibonacci sequence.• Define Fibonacci Sequence.• Objective Overview: State what students will learn, that is, derivation, properties and applications of the Fibonacci sequence.2. Content Delivery (30 minutes)<ul style="list-style-type: none">• Understanding the Fibonacci Sequence (10 minutes)• Solving Problems Involving Fibonacci Sequence (20 minutes)3. Active Engagement (5 minutes) Group Activity: Split students into groups to compute Fibonacci terms beyond and identify patterns or applications. |
| Closure | Recap: Define the Fibonacci sequence and its recurrence relation. Q&A Session: Address any questions or uncertainties. Final Question: "Can you think of other contexts where Fibonacci numbers or the Golden Ratio might appear?" |
| Evaluation | <ul style="list-style-type: none">• Class Participation: Monitor engagement during discussions and the group activity.• Homework Assignment of computing Fibonacci numbers up to certain value. |



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| Lesson Plan No. 07 | Course Name: Discrete Mathematics Topic: Tower of Hanoi | Course No.: MCA-104 |
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| Objectives | By the end of the lesson, students will be able to: <ol style="list-style-type: none"> Understand the rules and concept of the Tower of Hanoi puzzle. Solve the Tower of Hanoi puzzle for different numbers of disks. Apply recursive problem-solving strategies to solve the puzzle. |
| Teaching Aids (if any) | <input type="checkbox"/> Whiteboard/Marker or projector and slides <input type="checkbox"/> Tower of Hanoi physical puzzle set (optional) |
| Teaching Development | <ol style="list-style-type: none"> Engage the class: <ul style="list-style-type: none"> Begin with a simple question: "Have you ever played a puzzle or game where you have to move objects in a specific order?" Introduce the Problem(10 minutes): <ul style="list-style-type: none"> Introduce the Tower of Hanoi as a puzzle that involves moving disks between three rods with specific rules. Draw a simple diagram on the board showing three rods and a few disks stacked on one rod. Explain the rules of the Tower of Hanoi: <ol style="list-style-type: none"> Only one disk can be moved at a time. A disk can only be placed on an empty rod or on top of a larger disk. The goal is to move all disks from one rod to another using the fewest number of moves Teaching Development (30 minutes): <ul style="list-style-type: none"> Show the class a visual simulation of solving the Tower of Hanoi puzzle for 3 disks. (Can use an online simulation tool or a physical puzzle.) Introduce the concept of recursion by explaining how solving the Tower of Hanoi involves solving smaller versions of the same problem. Write the recursive formula on the board and explain it step by step. Guided Practice (10 minutes) <ul style="list-style-type: none"> Provide students with a simpler example (e.g., 2 disks) and guide them through solving it as a class. Ask questions to prompt thinking, such as: "What is the first move?", "What should we do with the largest disk?", etc. Allow students to suggest their moves and check their understanding. |
| Closure | Recap the Main Concepts: <ul style="list-style-type: none"> Quickly summarize the key points: rules of the game, the recursive nature of the solution, and how the number of moves increases exponentially with the number of disks ($2^n - 1$ moves). Reinforce the importance of recursion in breaking down complex problems into smaller, more manageable sub-problems. |



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| Evaluation | <ul style="list-style-type: none">• Ask the students to reflect: "What happens if we add more disks? How does the number of moves increase?"• Encourage students to discuss how this puzzle might relate to real-life applications (e.g., problem-solving, computer algorithms, data storage).• Spend 5 minutes to evaluate student assimilation of the lesson contents |
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| Lesson Plan No. 08 | Course Name: Discrete Mathematics Topic: Domain, range and inverse of relation | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none">1. Define the domain and range of a relation.2. Determine the domain and range from a given set of ordered pairs, graph, or mapping diagram.3. Explain the concept of an inverse of a relation.4. Compute the inverse of a given relation and verify it. |
| Teaching Aids (if any) | <ol style="list-style-type: none">a. Whiteboard and Markersb. Handouts for practice |
| Teaching Development | <ol style="list-style-type: none">1. Introduction (10 minutes) Objective: Engage students and review prerequisite knowledge. Begin with a question: "What do we mean by a relation in mathematics? Can someone provide an example?" Briefly review the definition of a relation as a set of ordered pairs.2. Teaching Development (35 minutes) Part A: Domain and Range (15 minutes) Objective: Teach students how to identify the domain and range.<ul style="list-style-type: none">• Definition and Explanation• Examples• Interactive PracticePart B: Inverse of a Relation (20 minutes) Objective: Explain and compute the inverse of a relation.<ul style="list-style-type: none">• Definition and Explanation• Examples• Guided Practice |
| Closure | Objective: Summarize key points and provide a chance for reflection. <ul style="list-style-type: none">• Recap the definitions of domain, range, and inverse of a relation.• Ask students to share examples of domains, ranges, and inverses they encountered during the lesson. |



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| Evaluation | Pose reflective questions: <ul style="list-style-type: none">• "Why is the domain of a relation important?"• "How does the inverse of a relation relate to the original?" Assign Homework to the students. |
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| Lesson Plan No. 09 | Course Name: Discrete Mathematics Topic: Types of relations | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none">1. Define and explain the concept of a relation in discrete mathematics.2. Identify and describe the different types of relations (reflexive, symmetric, antisymmetric, transitive, equivalence relations, and partial orders).3. Apply the properties of relations to determine the type of a given relation.4. Solve problems related to types of relations in a set. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <ol style="list-style-type: none">1. Introduction (10 minutes)<ul style="list-style-type: none">• Engage the Students by asking the questions from previous lesson.2. Teaching the Types of Relations (30 minutes) Give definitions and examples of Reflexive, Symmetric, Antisymmetric, Transitive, Equivalence and Partial Order relations.3. Guided Practice (10 minutes):<ul style="list-style-type: none">• Provide examples of relations and ask students to classify them based on their properties.• Solve one problem as a class and assign a similar problem for students to solve individually or in pairs. |
| Closure | <ol style="list-style-type: none">1. Summarize the lesson by revisiting the definitions and key properties of the types of relations.2. Highlight the real-world applications of relations (e.g., computer science, data modeling, set theory). |
| Evaluation | Ask a few reflective questions to ensure understanding: <ol style="list-style-type: none">1. "What makes a relation both symmetric and antisymmetric?"2. "Why is every equivalence relation reflexive?" <p>Assign Homework to the students.</p> |



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| Lesson Plan No. 10 | Course Name: Engineering Mathematics Topic: Closure of relations | Course No.: MCA-104 |
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| Objectives | By the end of the lesson, students will be able to: <ol style="list-style-type: none"> 1. Define the concept of closure in the context of relations. 2. Explain reflexive, symmetric, and transitive closures. 3. Apply algorithms to compute reflexive, symmetric, and transitive closures. 4. Analyze and verify the properties of a relation based on its closure. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <ol style="list-style-type: none"> 1. Introduction (10 minutes) <ul style="list-style-type: none"> • Warm-up Activity: Pose a quick question to review relations (e.g., "What are reflexive, symmetric, and transitive properties?"). • Real-World Connection: Relate the concept of closure to practical applications such as database design, graph theory, and reasoning systems. 2. Concept Explanation (30 minutes) <ul style="list-style-type: none"> • Definition of Closure: Explain the general idea of closure and its role in ensuring a relation meets specific properties. • Types of Closure: Provide detailed explanations for reflexive, symmetric, and transitive closures and illustrative examples. 3. Guided Practice (10 minutes) <ul style="list-style-type: none"> • Distribute handouts with small relations in tabular or matrix form. • Guide students to compute the reflexive, symmetric, and transitive closures for the given examples. |
| Closure | <ol style="list-style-type: none"> 1. Recap Key Points: Summarize the definitions and methods of finding closures. 2. Q&A Session: Allow students to ask questions and clarify doubts. 3. Preview Next Topic: Briefly introduce how closures are used in advanced topics, such as equivalence relations and graph algorithms. |
| Evaluation | <ol style="list-style-type: none"> 1. Class Participation: Monitor students' responses during discussions and guided practice. 2. Homework Assignment: Provide a set of relations for students to compute their closures and justify their steps. |



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| Lesson Plan No. 11 | Course Name: Discrete Mathematics Topic: Function and its types | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define a function and explain its key properties. 2. Differentiate between different types of functions (e.g., one-to-one, onto, bijective, constant, identity, etc.). 3. Provide examples and counterexamples for various types of functions. 4. Solve problems related to the classification of functions. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <ol style="list-style-type: none"> 1. Introduction (10 minutes) <ul style="list-style-type: none"> • Activity: Start with a real-life analogy to introduce the concept of a function (e.g., a vending machine where each button corresponds to a specific snack). • Key Points to Explain: State the key points to the students. 2. Development (20 minutes): State the definitions and examples of One-to-One (Injective), Onto (Surjective), Bijective, Constant Function, Identity Function etc. 3. Group Activity(15 mins): Divide students into small groups to solve a set of problems and classify functions based on provided descriptions. |
| Closure | <ul style="list-style-type: none"> • Discussion: Summarize the main points about function types. Reinforce key characteristics and examples of each type. • Homework Assignment: Classify the given functions into one-to-one, onto, bijective, or neither. |
| Evaluation | <ul style="list-style-type: none"> • Reflection Questions: <ul style="list-style-type: none"> ○ Why is it important to classify functions? ○ How can understanding function types help in solving real-world problems? <p>Spend 5 minutes to evaluate student assimilation of the lesson contents.</p> |



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| Lesson Plan No. 12 | Course Name: Discrete Mathematics Topic: Sum and product of functions | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none">1. Define the sum and product of functions.2. Understand and compute the sum and product of given functions.3. Apply the concepts to solve real-world problems and mathematical expressions involving functions. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <p>1. Introduction (10 minutes)</p> <ul style="list-style-type: none">• Objective: Introduce the concepts of functions and their operations.• Begin with a quick review of functions and their representations (e.g., algebraic, graphical). <p>2. Teaching Development (25 minutes)</p> <ul style="list-style-type: none">• Sum of Functions (10 minutes): Define the sum of two functions, illustrate with examples.• Product of Functions (10 minutes): Define the product of two functions and work through examples.• Connection to Real-world Problems (5 minutes) |
| Closure | <ul style="list-style-type: none">• Summarize key points.• Address any remaining questions.• Spend 5 minutes to wrap up and consolidate the learning's. |
| Evaluation | Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents. |



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| Lesson Plan No. 13 | Course Name: Discrete Mathematics Topic: Floor and Ceil functions | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define floor and ceil functions and explain their significance. 2. Compute the floor and ceiling of real numbers with given examples. 3. Apply floor and ceiling functions in problem-solving contexts such as algorithms and real-world applications. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <ol style="list-style-type: none"> 1. Introduction (10 minutes) <ul style="list-style-type: none"> • Start with a real-life scenario involving rounding up or down (e.g., splitting a bill, scheduling tasks). • Define the floor function as the greatest integer less than or equal to x and the ceil function as the smallest integer greater than or equal to x. 2. Development (20 minutes) 3. Guided Practice (15 minutes): Provide a list of real numbers and ask students to compute floor and ceil values and encourage them to verify their understanding by explaining their reasoning to peers. |
| Closure | <ul style="list-style-type: none"> • Recap the definitions, key properties, and applications of floor and ceil functions. • Homework: Provide a worksheet with numerical and application-based problems. |
| Evaluation | <p>Ask reflective questions like:</p> <ul style="list-style-type: none"> • How do floor and ceil functions differ in handling negative numbers? • Can both functions yield the same result? If so, when? <p>Spend 5 minutes to evaluate student assimilation of the lesson contents.</p> |



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| Lesson Plan No. 14 | Course Name: Discrete Mathematics Topic: Characteristic, Remainder and Hash functions | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define characteristic, remainder, and hash functions and understand their roles in mathematical and computational contexts. 2. Compute characteristic and remainder functions for given inputs. 3. Explain the significance of hash functions and analyze their applications in data structures and cryptography. 4. Solve practical problems involving characteristic, remainder, and hash functions. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>1. Introduction (10 minutes)</p> <ul style="list-style-type: none"> • Begin with a quick activity related to characteristic, remainder, and hash functions. • Provide the definitions of Characteristic Function, Remainder Function and Hash Function. <p>2. Development (25 minutes)</p> <ul style="list-style-type: none"> • Step 1: Characteristic Function (10 minutes): Illustrate with an example and discuss applications in logic and set theory. • Step 2: Remainder Function (10 minutes): Solve examples, highlight properties and discuss its role in modular arithmetic and number theory. • Step 3: Hash Functions (5 minutes): Provide a simple hash function example and discuss hash tables and their application in searching, encryption, and load balancing. <p>3. Guided Practice (15 minutes): Solve problems interactively and encourage students to identify scenarios where each function is useful.</p> |
| Closure | <ul style="list-style-type: none"> • Summarize the key concepts covered in the lesson. • Confirm students' understanding and answer any remaining questions. • Homework: Assign problems on applying properties of definite integrals to different functions. |
| Evaluation | <ul style="list-style-type: none"> • Reflective Questions (What Why Who?): Allow students to discuss and reflect on these questions. • Spend 5 minutes to evaluate students' understanding through a short quiz or discussion. |



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| Lesson Plan No. 15 | Course Name: Discrete Mathematics Topic: Basic terminology of Graphs | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define basic graph-related terms, such as vertex, edge, degree, path, cycle, connected graph, and others. 2. Differentiate between types of graphs (e.g., directed, undirected, weighted, unweighted). |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Start with a real-life example and explain that graphs are mathematical structures used to model pairwise relationships.</p> <p>Development (25 minutes)</p> <p>Basic Terminology (15 minutes): Define and explain key terms like vertex, edge, degree, path, cycle etc. with examples.</p> <p>Types of Graphs (10 minutes): Explain and illustrate with comparative examples the following types of graphs: Directed vs. Undirected Graphs, Weighted vs. Unweighted Graphs, Simple Graph vs Multigraph etc.</p> <p>Guided Practice (15 minutes)</p> <ul style="list-style-type: none"> • Work through examples with the class: <ol style="list-style-type: none"> 1. Draw a simple graph and identify the vertices, edges, degrees, and paths. 2. Given a graph, determine if it is directed or undirected, weighted or unweighted. 3. Analyze a connected graph to verify connectivity. |
| Closure | <ul style="list-style-type: none"> • Recap the key terms and types of graphs. • Emphasize the importance of graph theory in various applications like networks, scheduling, and data organization. • Assign homework to the students. |
| Evaluation | <ul style="list-style-type: none"> • Pose reflective questions like How, What and Why? • Spend 5 minutes to wrap up and consolidate |



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| Lesson Plan No. 16 | Course Name: Discrete Mathematics Topic: Types of Graphs | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to differentiate between types of graphs (e.g., directed, undirected, weighted, unweighted). |
| Teaching Aids (if any) | <ul style="list-style-type: none">Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none">Begin with a question: <i>What kind of networks do you encounter in daily life? (e.g., road maps, social networks, communication networks).</i>Introduce the concept of a graph to answer the question above. <p>Development (25 minutes): Define and illustrate with various types of examples, that is, Undirected and Directed Graphs, Weighted and Unweighted Graphs and other special types of graphs like simple graph, multigraph, complete, bipartite, planar, cyclic and acyclic graphs.</p> <p>Guided Practice (15 minutes): Provide examples of graphs and ask students to identify the type of graph (e.g., directed, weighted, simple).</p> <p>Classify a given graph as cyclic or acyclic, planar or non-planar.</p> |
| Closure | <ul style="list-style-type: none">Summarize the types of graphs and their unique properties.Discuss the importance of identifying graph types for solving problems in areas like networking, logistics, and scheduling.Spend 5 minutes to wrap up and consolidate. |
| Evaluation | <p>1. Pose reflective questions:</p> <p><i>Why might we use a weighted graph instead of an unweighted one in certain situations?</i></p> <p><i>What advantages does a tree (acyclic graph) have over other graph types?</i></p> |



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| Lesson Plan No. 17 | Course Name: Discrete Mathematics Topic: Operations on Graphs | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Understand and perform basic operations on graphs, including union, intersection, difference, and complement. 2. Apply these graph operations to solve problems in graph theory. 3. Explain how graph operations are used in real-world scenarios, such as network analysis, scheduling, and optimization. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>1. Introduction (10 minutes)</p> <ul style="list-style-type: none"> • Begin with a question to the class: <i>How do we combine or manipulate multiple graphs to obtain a new graph?</i> • Explain that just like set theory, graphs also have operations that allow us to combine, modify, and manipulate graphs. • Introduce the concept of graph operations as methods to manipulate graphs to study their properties or find solutions to real-world problems. <p>Development (25 minutes)</p> <p>Step 1: Union of Graphs (10 minutes): Definition, Examples and illustration through drawing graphs and their union to show the combined vertices and edges.</p> <p>Step 2: Intersection of Graphs (8 minutes): Definition, Examples and illustration through drawing graphs and their intersection which includes only the vertices and edges that are common to both graphs.</p> <p>Step 3: Difference of Graphs (7 minutes): Definition, Examples and illustration through drawing graphs and their difference where some vertices and edges are removed from the first graph.</p> <p>Guided Practice (15 minutes): Provide examples for students to perform the graph operations. Walk around and assist students as they work through the problems on paper or using graph drawing tools.</p> |
| Closure | <ul style="list-style-type: none"> • Summarize the key concepts covered in the lesson. • Discuss the importance of graph operations in network analysis, data |



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| | structure manipulation, and algorithms. |
| Evaluation | <ul style="list-style-type: none">• Pose reflective questions: <i>In what real-world scenarios could the union of two graphs be useful? Why is the complement of a graph useful in algorithms like finding unreachable nodes or detecting missing connections?</i>• Homework Assignment: <i>A worksheet with mixed problems on graph operations.</i> |



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| Lesson Plan No. 18 | Course Name: Discrete Mathematics Topic: Spanning trees and their applications | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define and understand the concept of a spanning tree in a graph. 2. Differentiate between spanning trees and other subgraphs. 3. Identify and construct spanning trees from given graphs. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none"> • Begin with a question: <i>How do we connect a set of points with minimal wiring or cost while maintaining connectivity?</i> • Explain that spanning trees are subgraphs that connect all vertices in a graph with the minimum number of edges (i.e., no cycles). • Provide a formal definition and characteristics of a spanning tree. <p>Development (25 minutes)</p> <p>Step 1: Basic Concepts (10 minutes)</p> <p>Explain with examples and discuss properties of spanning trees.</p> <p>Step 2: Minimum Spanning Trees (10 minutes)</p> <p>Introduce the concept of a minimum spanning tree (MST), discuss and explain the algorithms to find MSTs, that is, Kruskal’s Algorithm and Prim’s Algorithm. Work through a step-by-step example for both algorithms.</p> <p>Step 3: Applications (5 minutes)</p> <p>Discuss real-world applications of spanning trees in Network Design, Approximation Algorithms, Cluster Analysis, Broadcasting etc.</p> <p>Guided Practice (15 minutes): Provide the students with a graph and ask them to draw a spanning tree of the graph and apply Kruskal’s and Prim’s algorithms to find the MST.</p> <p>Discuss the results as a class and ensure everyone understands the steps involved in each algorithm.</p> |
| Closure | Recap the key points: <ul style="list-style-type: none"> • Definition and properties of spanning trees. • Difference between spanning trees and minimum spanning trees. |





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| | <ul style="list-style-type: none">• Applications in real-world problems. |
| Evaluation | <p>Ask reflective questions:</p> <ul style="list-style-type: none">• <i>Why is it important that a spanning tree has no cycles?</i>• <i>Which algorithm (Kruskal's or Prim's) is easier to implement in practice and why?</i> <p>Take 5 mins to discuss the results with the students.</p> |



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| Lesson Plan No. 19 | Course Name: Discrete Mathematics Topic: Shortest path in graphs | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> Understand the concept of the shortest path in a graph. Differentiate between weighted and unweighted graphs in the context of shortest path problems. Apply algorithms such as Dijkstra's, Bellman-Ford, and BFS for finding the shortest path. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none"> Start with a question: <i>How would you find the shortest route between two locations on a map?</i> Introduce the shortest path problem: <ul style="list-style-type: none"> In an unweighted graph, it's the path with the fewest edges. In a weighted graph, it's the path with the minimum sum of edge weights. <p>Development (25 minutes)</p> <p>Step 1: Shortest Path in Unweighted Graphs (5 minutes): Explain using Breadth-First Search (BFS)</p> <p>Step 2: Shortest Path in Weighted Graphs (30 minutes)</p> <ul style="list-style-type: none"> Dijkstra's Algorithm Bellman-Ford Algorithm <p>Step 3: Comparison of Algorithms</p> <p>Step 4: Applications</p> <p>Guided Practice (15 minutes): Provide graphs for students to solve the following:</p> <ul style="list-style-type: none"> Use BFS to find the shortest path in an unweighted graph. Apply Dijkstra's algorithm to find the shortest path in a weighted graph. Use Bellman-Ford to find the shortest path in a graph with negative edge weights. Discuss the results and verify correctness. |



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| Closure | Summarize key points: <ul style="list-style-type: none">• The difference between shortest paths in weighted and unweighted graphs.• The importance of algorithms like Dijkstra's and Bellman-Ford. |
| Evaluation | Pose reflective questions: <ul style="list-style-type: none">• <i>What happens if a graph contains negative cycles?</i>• <i>Why is Dijkstra's algorithm inefficient for graphs with negative edges?</i>• Spend 5 minutes to wrap up and consolidate. |



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| Lesson Plan No. 20 | Course Name: Engineering Mathematics Topic: Planarity of Graphs | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define and understand the concept of planar graphs. 2. Identify planar and non-planar graphs using Euler’s formula and Kuratowski’s theorem. 3. Understand the significance of planarity in graph theory and real-world applications. 4. Apply techniques to determine graph planarity through graph embeddings and visualization. |
| Teaching Aids (if any) | <ul style="list-style-type: none"> • Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a scenario: <i>Imagine designing a circuit board. How can you connect components without wires crossing unnecessarily?</i></p> <p>Explain that this is a problem of planarity, where we determine if a graph can be drawn on a plane without edges crossing and introduce the concept of planar graphs.</p> <p>Development (25 minutes)</p> <p>Step 1: Characteristics of Planar Graphs (10 minutes)</p> <p>Step 2: Non-Planar Graphs and Kuratowski’s Theorem (10 minutes)</p> <p>Step 3: Planar Graph Embedding (5 minutes)</p> <p>Guided Practice (15 minutes): Provide students with graphs and ask them to:</p> <ul style="list-style-type: none"> • Determine if the graph is planar using Euler’s formula. • Attempt to draw the graph in a planar form, if possible. • Walk around to assist students and clarify doubts. |
| Closure | Recap the key points: <ul style="list-style-type: none"> • Definition of planar graphs and importance in real-world applications like circuit design and map coloring. • Euler’s formula and its role in verifying planarity. • Kuratowski’s theorem and its significance in identifying non-planar graphs. |



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| Evaluation | Pose reflective questions: <ul style="list-style-type: none">• <i>Why do we care about planarity in practical problems like transportation networks or communication lines?</i>• <i>How does planarity help in minimizing crossing edges in a graph representation?</i>• Allow students to discuss and reflect on these questions. |
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| Lesson Plan No. 21 | Course Name: Discrete Mathematics Topic: Eulerian and Hamiltonian paths and circuits | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Understand the concepts of Eulerian paths, Eulerian circuits, Hamiltonian paths, and Hamiltonian circuits. 2. Differentiate between Eulerian and Hamiltonian paths/circuits. 3. Identify Eulerian and Hamiltonian paths/circuits in given graphs. 4. Apply necessary and sufficient conditions to determine if a graph has an Eulerian path or circuit. 5. Recognize real-world applications of Eulerian and Hamiltonian paths. |
| Teaching Aids (if any) | <ul style="list-style-type: none"> • Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a question: <i>How can you traverse every street in a city without retracing steps, or visit every city on a map exactly once?</i></p> <p>Introduce the concepts with definitions of Eulerian Path, Eulerian Circuit, Hamiltonian Path and Hamiltonian Circuit.</p> <p>Development (30 minutes)</p> <p>Step 1: Eulerian Paths and Circuits (15 minutes)</p> <p>Step 2: Hamiltonian Paths and Circuits (15 minutes)</p> <p>Guided Practice (15 minutes) Provide students with graphs to:</p> <ul style="list-style-type: none"> • Determine if the graph has an Eulerian path or circuit using degree-based rules. • Identify whether a Hamiltonian path or circuit exists using heuristics. • Explain why the graph is or isn't Eulerian or Hamiltonian. • Solve one example collaboratively, then allow students to work independently or in pairs. |
| Closure | <ol style="list-style-type: none"> 1. Recap the key differences between Eulerian and Hamiltonian paths and circuits. 2. Discuss the importance of each in real-world applications: <ol style="list-style-type: none"> (a) Eulerian paths in optimizing routes (e.g., garbage collection). (b) Hamiltonian paths in scheduling and logistics. |



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| Evaluation | Pose reflective questions: <ul style="list-style-type: none">• <i>Why do Eulerian paths focus on edges while Hamiltonian paths focus on vertices?</i>• <i>How might you approach solving a Hamiltonian path problem for large graphs?</i>• Allow students to discuss and reflect on these questions. |
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| Lesson Plan No. 22 | Course Name: Discrete Mathematics Topic: Tree and its properties | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define a tree in graph theory and identify its key characteristics. 2. Understand the properties of trees and how they differ from other graphs. 3. Recognize different types of trees (e.g., rooted, binary). |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a question: <i>What do family trees, organizational charts, and decision-making processes have in common?</i></p> <p>Explain that these are examples of trees in graph theory, which are acyclic and connected.</p> <p>Development (25 minutes)</p> <ul style="list-style-type: none"> • Step 1: Properties of Trees (10 minutes) • Step 2: Types of Trees (5 minutes) • Step 3: Real-World Applications of Trees (5 minutes) • Step 4: Problem-Solving Using Tree Properties (5 minutes) <p>Guided Practice (15 minutes): Provide students with tasks:</p> <ul style="list-style-type: none"> • Verify whether given graphs are trees. • Count vertices, edges, and check acyclic/connected properties. • Draw a spanning tree for a given graph. • Discuss solutions collaboratively or in groups |
| Closure | Recap key points: <ul style="list-style-type: none"> • Definition of a tree and its essential properties. • Types of trees and their applications. • Why trees are foundational in graph theory and problem-solving. |
| Evaluation | Pose reflective questions like <ul style="list-style-type: none"> • <i>How would you use tree properties to model hierarchical data?</i> • Spend 5 minutes to evaluate students' understanding through a short quiz or discussion. |



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| Lesson Plan No. 23 | Course Name: Discrete Mathematics Topic: Minimal Spanning trees | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define a minimal spanning tree (MST) and understand its significance in graph theory. Identify the properties and applications of MSTs. Implement algorithms like Kruskal's and Prim's to find MSTs. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Define and explain a spanning tree and a minimal spanning tree (MST).</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> Step 1: Properties of Minimal Spanning Trees (10 minutes) Step 2: Algorithms for Finding MSTs (20 minutes) Kruskal's Algorithm and Prim's Algorithm. <p>Guided Practice (15 minutes): Provide a weighted graph and ask students to</p> <ul style="list-style-type: none"> solve for the MST using Kruskal's algorithm. solve for the MST using Prim's algorithm. Walk around the room to assist and clarify doubts. |
| Closure | Recap key points: <ul style="list-style-type: none"> Definition of MSTs and their properties. Importance of MSTs in practical applications like network design, clustering, and optimization. Overview of Kruskal's and Prim's algorithms. |
| Evaluation | Post reflective questions: <ul style="list-style-type: none"> <i>How do MST algorithms ensure cycle-free solutions?</i> <i>Why might Kruskal's algorithm be preferable in some cases and Prim's in others?</i> Spend 5 minutes to evaluate students' understanding through a short quiz or discussion. |



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| Lesson Plan No. 24 | Course Name: Discrete Mathematics Topic: Cut Sets | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define a cut set in the context of graph theory. Understand the properties and significance of cut sets. Identify cut sets in different types of graphs. |
| Teaching Aids (if any) | <ul style="list-style-type: none"> Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a question: <i>What happens if you remove certain edges or vertices in a network, and it disconnects the network?</i></p> <p>Define a cut set and illustrate with simple examples.</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> Step 1: Definition and Properties of Cut Sets (10 minutes) Step 2: Visual Examples (10 minutes) Step 3: Applications of Cut Sets (10 minutes) <p>Guided Practice (15 minutes) Provide students with tasks:</p> <ul style="list-style-type: none"> Identify cut sets in provided graphs. Verify whether removing specific edges forms a valid cut set. Solve a basic network flow problem to demonstrate the use of cut sets in finding bottlenecks. Discuss solutions collaboratively or in small groups. |
| Closure | Recap key points: <ul style="list-style-type: none"> Definition and importance of cut sets. Role of cut sets in maintaining graph connectivity. Applications of cut sets in practical scenarios. |
| Evaluation | <p>Pose reflective questions:</p> <ul style="list-style-type: none"> <i>How do cut sets relate to network robustness?</i> <i>Why are minimal cut sets important in optimization problems?</i> <p>Spend 5 minutes to evaluate students' understanding through a short quiz or discussion</p> |



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| Lesson Plan No. 25 | Course Name: Discrete Mathematics Topic: Coloring of Graphs | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define graph coloring and its different types (vertex coloring, edge coloring, and face coloring). Understand the chromatic number of a graph and its significance. Apply graph coloring techniques to solve problems, such as scheduling and resource allocation. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Start with a real-world question: <i>How can you assign different frequencies to cell towers to avoid interference?</i></p> <p>Introduce the concept of graph coloring and define key terms like Chromatic number.</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> Step 1: Vertex Coloring (10 minutes) Step 2: Edge Coloring (5 minutes) Step 3: Face Coloring (5 minutes) Step 4: Applications of Graph Coloring (10 minutes) <p>Guided Practice (15 minutes) Provide students with tasks:</p> <ul style="list-style-type: none"> Determine the chromatic number for given graphs. Apply edge coloring to a given graph with specified constraints. Solve a scheduling problem using vertex coloring techniques. |
| Closure | Recap key points: <ul style="list-style-type: none"> Types of graph coloring: vertex, edge, and face coloring. Chromatic number and its significance. |
| Evaluation | Pose reflective questions: <ul style="list-style-type: none"> <i>Why is graph coloring important in real-world scenarios?</i> <i>What factors affect the chromatic number of a graph?</i> <p>Spend 5 minutes to evaluate students' understanding through a short quiz or discussion.</p> |



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| Lesson Plan No. 26 | Course Name: Discrete Mathematics Topic: Chromatic Number and Chromatic polynomial | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define the chromatic number of a graph and understand its significance. Calculate the chromatic number of various graphs. Define the chromatic polynomial of a graph and explain its role in graph coloring. |
| Teaching Aids (if any) | <ul style="list-style-type: none"> Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Pose a question to the class: <i>How can we determine the minimum number of colors needed to color a graph such that no two adjacent vertices share the same color?</i></p> <p>Define the chromatic number and explain its significance.</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> Step 1: Chromatic Number (15 minutes) Step 2: Chromatic Polynomial (15 minutes) <p>Guided Practice (15 minutes): Provide students with tasks:</p> <ul style="list-style-type: none"> Calculate the chromatic number of given graphs (e.g., trees, complete graphs, bipartite graphs). Derive the chromatic polynomial of a graph with up to four vertices using the deletion-contraction method. |
| Closure | Recap key points: Definition and importance of the chromatic number and chromatic polynomial. |
| Evaluation | <p>Pose reflective questions:</p> <ul style="list-style-type: none"> <i>How does the chromatic number relate to the structure of a graph?</i> <i>What does the chromatic polynomial reveal that the chromatic number does not?</i> <p>Spend 5 minutes to evaluate students' understanding through a short quiz or discussion.</p> |



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| Lesson Plan No. 27 | Course Name: Discrete Mathematics Topic: The four color problem | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Understand the statement and significance of the Four Color Problem and explain its proof. Apply the Four Color Theorem to simple map-coloring problems. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a question: <i>How many colors do you think are needed to color a map so that no two adjacent regions share the same color?</i></p> <p>Introduce the Four Color Problem and highlight its importance.</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> Step 1: History and Statement of the Four Color Theorem (10 minutes) Step 2: Graph-Theoretic Formulation (10 minutes) Step 3: Applications of the Four Color Theorem (10 minutes) <p>Guided Practice (15 minutes): Provide students with tasks:</p> <ul style="list-style-type: none"> Represent a simple map as a planar graph. Apply the Four Color Theorem to color the graph. Discuss whether fewer than four colors are possible for specific examples. |
| Closure | Recap key points: <ul style="list-style-type: none"> Statement and significance of the Four Color Theorem. The transition from map coloring to planar graph representation. |
| Evaluation | Pose reflective questions: <ul style="list-style-type: none"> <i>Why do you think the proof of the Four Color Theorem required computational assistance?</i> <i>Can you think of other problems where graph coloring might be useful?</i> <p>Spend 5 minutes to evaluate students' understanding.</p> |



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| Lesson Plan No. 28 | Course Name: Discrete Mathematics Topic: Edge Coloring and Coloring Algorithm | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define edge coloring and explain its purpose in graph theory. 2. Apply edge coloring algorithms to simple graphs. 3. Explore real-world applications of edge coloring. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a question: <i>How can we assign time slots or frequencies to connections in a network to avoid conflicts at shared nodes?</i></p> <p>Introduce edge coloring and highlight key applications.</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> • Step 1: Definition and Basics of Edge Coloring (10 minutes) • Step 2: Vizing's Theorem (10 minutes) • Step 3: Edge Coloring Algorithms (10 minutes) <p>Guided Practice (15 minutes): Provide students with tasks:</p> <ul style="list-style-type: none"> • Apply the greedy edge coloring algorithm to a given graph. • Determine the chromatic index for a simple graph using Vizing's theorem. • Solve a scheduling problem by representing it as an edge coloring problem. |
| Closure | Recap key points: <ul style="list-style-type: none"> • Definition and importance of edge coloring. • Vizing's theorem and its significance in determining the chromatic index. • Application of algorithms for edge coloring. |
| Evaluation | <p>Pose reflective questions:</p> <ul style="list-style-type: none"> • <i>Why is edge coloring significant in resource allocation problems?</i> • <i>How does Vizing's theorem simplify the process of determining the chromatic index?</i> <p>Spend 5 minutes to evaluate students' understanding through a short quiz or discussion.</p> |



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| Lesson Plan No. 29 | Course Name: Discrete Mathematics Topic: Applications of trees and graph coloring | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> • Explain real-world applications of trees in computer science, networking, and decision-making. • Understand the significance of graph coloring in scheduling, resource allocation, and optimization problems. • Solve practical problems using trees and graph coloring techniques. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with two questions: <i>What makes tree structures unique and efficient in computer science?</i> <i>Why is assigning colors to graphs useful in solving real-world problems?</i></p> <p>Introduce the topics: Trees and Graph Coloring.</p> <p>Development (30 minutes)</p> <ul style="list-style-type: none"> • Step 1: Applications of Trees (15 minutes) • Step 2: Applications of Graph Coloring (15 minutes) <p>Guided Practice (15 minutes)</p> <ul style="list-style-type: none"> • Identify and draw a tree structure for a given problem (e.g., representing a company hierarchy). • Solve a simple MST problem for a given network graph using Prim's or Kruskal's algorithm. • Apply graph coloring to schedule exams for a set of overlapping courses. |
| Closure | Recap key points: <ul style="list-style-type: none"> • The versatility of trees in hierarchical, network, and decision-making applications. • The importance of graph coloring in resolving conflicts and optimizing resources. |
| Evaluation | Pose reflective questions: <ul style="list-style-type: none"> • <i>Can you think of a real-world problem that could be solved using graph coloring?</i> • <i>What are the advantages of using tree structures in algorithms and networks?</i> <p>Spend 5 minutes to evaluate students' understanding through a short quiz or discussion.</p> |



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| Lesson Plan No. 30 | Course Name: Discrete Mathematics Topic: Propositions, connectives, conditionals and biconditionals | Course No.: MCA-104 |
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| Objectives | By the end of the lesson, students will be able to: <ol style="list-style-type: none"> 1. Define propositions, connectives, conditionals, and biconditionals. 2. Apply logical connectives to construct compound propositions. 3. Differentiate between conditionals and biconditionals in terms of their truth values. 4. Evaluate the truth values of complex logical statements using truth tables. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none"> • Activity: Begin with a quick warm-up asking students everyday examples of statements (e.g., "The sky is blue," "I will go to the gym if I finish my homework"). • Discussion: Highlight how these statements can be classified as true or false and introduce the concept of a proposition (a declarative statement that is either true or false). • Objective Overview: Briefly outline what students will learn in this session. <p>Main Content (50 minutes)</p> <ul style="list-style-type: none"> • Propositions and Logical Connectives (15 minutes) • Truth Tables (15 minutes) • Conditionals (If-Then Statements) (10 minutes) • Biconditionals (10 minutes) <p>Guided Practice (10 minutes)</p> <ul style="list-style-type: none"> • Provide a set of logical statements combining connectives, conditionals, and biconditionals. • Work through one example with the class, then allow students to work in pairs on the rest. |
| Closure | <ul style="list-style-type: none"> • Recap: Summarize key points about propositions, connectives, conditionals, and biconditionals. • Preview: Briefly mention how these ideas will be expanded in future |



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| | lessons (e.g., logical equivalence, argument validity). |
| Evaluation | <ul style="list-style-type: none">• Reflection Question: Ask students, "How do these concepts help us reason logically in everyday life?"• Allow students to discuss and reflect on these questions.• Spend 5 minutes to evaluate students' understanding through a short quiz or discussion |



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| Lesson Plan No. 31 | Course Name: Discrete Mathematics Topic: Well-formed formulas and equivalence of formulas | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none"> 1. Define and identify well-formed formulas (WFFs) in propositional logic. 2. Explain the rules for constructing WFFs. 3. Analyze and evaluate logical equivalence between formulas. 4. Apply equivalence laws to simplify or transform logical formulas. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 Minutes)</p> <ol style="list-style-type: none"> 1. Motivation/Hook: Start with a real-world analogy (e.g., grammar in language vs. syntax in logic). Discuss how rules ensure meaningful statements in language and logic. 2. Objective Setting: Share the learning objectives and outline of the session. <p>Main Lesson (60 Minutes)</p> <p>Part 1: Well-Formed Formulas (WFFs)</p> <p>Definition (5 Minutes): Define WFFs as syntactically correct expressions in propositional logic constructed according to specific rules. Rules for Constructing WFFs (10 Minutes): Use examples to construct valid WFFs step by step.</p> <p>Part 2: Equivalence of Formulas: Logical Equivalence (10 Minutes) and Equivalence Laws (15 Minutes).</p> <p>Part 3: Practice and Discussion (20 Minutes)</p> <p>Activity:</p> <ul style="list-style-type: none"> • Provide students with formulas to classify as WFFs or non-WFFs. • Ask students to simplify a given formula using equivalence laws. <p>Collaborative Problem-Solving: Break students into groups to work on proving equivalences.</p> |
| Closure | Recap: |



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| | <ul style="list-style-type: none">• Summarize the rules for WFFs and the importance of equivalence in simplifying logical statements.• Reiterate key equivalence laws and their applications. <p>Q&A Session: Address any questions from the class.</p> |
| Evaluation | <p>Formative Assessment:</p> <ul style="list-style-type: none">• Monitor participation in activities and group discussions.• Collect and evaluate exit tickets for understanding. |



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| Lesson Plan No. 32 | Course Name: Discrete Mathematics Topic: Tautologies and duality law | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ol style="list-style-type: none">1. Define and identify tautologies in propositional logic.2. Explain the concept of duality in logical expressions.3. Apply the duality law to rewrite logical expressions.4. Analyze the significance of tautologies and duality in mathematical reasoning and problem-solving. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Begin with a thought-provoking question, such as: “Can you think of a statement in logic that is always true, no matter the truth values of its components?”</p> <p>Give definitions of Tautology and Duality Law and highlight their importance.</p> <p>Main Activity (30 minutes)</p> <ol style="list-style-type: none">1. Tautologies (15 minutes): Explain and practice exercises.2. Duality Law (15 minutes): Explain and practice exercises. <p>Group Activity (10 minutes) Split the class into small groups and assign tasks:</p> <ul style="list-style-type: none">• Group A: Create a truth table for a complex formula to verify if it’s a tautology.• Group B: Write a logical expression and its dual, then verify the equivalence.• Discuss and share results as a class. |
| Closure | <p>Review Questions: What is a tautology, and why is it important?</p> <p>How does the duality law help in simplifying logical expressions?</p> <p>Real-Life Connection: Briefly discuss applications in computer science, such as circuit design and programming logic.</p> |
| Evaluation | <ol style="list-style-type: none">1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. <p>Spend 5 minutes to evaluate student assimilation of the lesson contents.</p> |



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| Lesson Plan No. 33 | Course Name: Discrete Mathematics Topic: Normal Forms | Course No.: MCA-104 |
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| Objectives | <p>By the end of the lesson, students will be able to:</p> <ul style="list-style-type: none"> Define normal forms (Conjunctive Normal Form (CNF) and Disjunctive Normal Form (DNF)). Understand the process of converting logical expressions into CNF and DNF. Apply the concepts of normal forms to simplify and standardize logical expressions. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none"> Begin with a brief discussion on the importance of standardizing logical expressions in computer science, AI, and digital circuits. Define normal forms and emphasize their role in logical equivalence and computational applications. <p>Teaching Concepts (30 minutes) Teach the concepts of Conjunctive Normal Form (CNF) and Disjunctive Normal Form (DNF) by stating and explaining their definitions, examples and differences.</p> <p>Student Activity (20 minutes)</p> <ul style="list-style-type: none"> Distribute worksheets with several logical expressions for students to convert to CNF and DNF. Include both simple and complex problems, encouraging group work and discussion. |
| Closure | <ul style="list-style-type: none"> Recap the importance of normal forms and the key steps in their conversion. Highlight potential pitfalls, such as forgetting to distribute properly or mishandling negations. Assign problems on finding the basis and dimension of given vector spaces. Spend 5 minutes to wrap up and consolidate the learning. |
| Evaluation | <p>Pose a thought-provoking question: “Why do SAT solvers prefer CNF over DNF for solving logical problems?”</p> <ul style="list-style-type: none"> Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents. |



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| Lesson Plan No. 34 | Course Name: Discrete Mathematics Topic: Inference theory for propositional calculus | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define inference theory and its role in propositional calculus. Differentiate between valid arguments, sound arguments, and inference rules. Apply commonly used inference rules such as Modus Ponens, Modus Tollens, and Resolution. Construct and validate arguments using inference rules in propositional logic. |
| Teaching Aids (if any) | Whiteboard and Markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none"> Opening Question: "If it rains, I'll carry an umbrella. It's raining. What can you infer?" Use the students' responses to highlight the idea of logical inference. Define inference theory: the process of deriving new propositions (conclusions) from given propositions (premises) using formal rules. <p>Teaching Concepts (30 minutes)</p> <p>Basics of Inference Theory</p> <ul style="list-style-type: none"> Valid Argument: An argument is valid if the conclusion logically follows from the premises. Sound Argument: An argument is sound if it is valid and all premises are true. Rules of Inference Introduce each rule with its symbolic form and an example: <ol style="list-style-type: none"> Modus Ponens (MP) Modus Tollens (MT) Hypothetical Syllogism (HS) Disjunctive Syllogism (DS) Constructing Proofs Consistency and Validity <p>C. Student Activity (20 minutes)</p> <p>Practice Problems:</p> <ol style="list-style-type: none"> Solve problems using Modus Ponens, Modus Tollens, and Resolution. |



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| | 2. Identify the inference rules used in given proofs. |
| Closure | <p>Recap key inference rules and their importance in constructing logical proofs.</p> <p>Pose a challenge: <i>"Why is inference theory critical in automated theorem proving and AI systems?"</i></p> <p>Encourage students to reflect on real-life applications like programming, database queries, and AI reasoning.</p> |
| Evaluation | <p>Homework Assignment</p> <p>Assign a set of logical arguments for students to prove using inference rules.</p> <p>Include reflective questions like: <i>"Which inference rule did you find most intuitive? Why?"</i></p> |



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| Lesson Plan No. 35 | Course Name: Discrete Mathematics Topic: Predicate Calculus | Course No.: MCA-104 |
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| Objectives | By the end of the lesson, students will be able to: <ul style="list-style-type: none"> Define predicate calculus and differentiate it from propositional calculus. Understand the role of quantifiers (universal and existential) in predicate logic. Apply predicate calculus in solving logical problems and proofs. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <ul style="list-style-type: none"> Ask: "How would you represent the statement 'All humans are mortal' in logic?" Highlight the need for a logical system that deals with the structure within statements, leading to predicate calculus. <p>Teaching Concepts (30 minutes)</p> <ul style="list-style-type: none"> Predicates and Quantifiers; Syntax and Semantics Translating Natural Language and Logical Equivalences in Predicate Logic Applications of Predicate Logic <p>Student Activity (20 minutes): Translate the following sentences into predicate logic:</p> <ul style="list-style-type: none"> "Every cat is a mammal." "There is a car that is red." "Not all birds can fly." |
| Closure | Recap the key points: predicates, quantifiers, and their usage in formalizing statements. Pose an open-ended question: "How do you think predicate logic contributes to the development of AI reasoning systems?" |
| Evaluation | In-Class Assessment <ul style="list-style-type: none"> Review the students' work on translating statements to predicate logic. Discuss solutions and address common misconceptions. Spend 5 minutes to wrap up and consolidate |



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| Lesson Plan No. 36 | Course Name: Discrete Mathematics Topic: Inference theory for predicate calculus | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define inference theory in the context of predicate calculus. Apply inference rules to arguments in predicate logic, including rules for quantifiers. Understand the role of unification and substitution in predicate logic. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Contextual Question:</p> <ul style="list-style-type: none"> <i>Pose a simple question: "If every student passed the test, and Alice is a student, what can we infer about Alice?"</i> <i>Use the answer to introduce inference theory in predicate calculus.</i> <p>Development (10 minutes)</p> <ol style="list-style-type: none"> Review of Predicate Logic Basics Inference Rules in Predicate Calculus Unification and Substitution Formal Proofs in Predicate Logic Applications and Limitations <p>Exercise (25 minutes)</p> <p>Group Activity</p> <ul style="list-style-type: none"> Scenario: "If all cats are mammals, and some animals are cats, what can we infer?" Task: Write the premises and derive the conclusion step by step. |
| Closure | <ul style="list-style-type: none"> Recap key inference rules (UI, EG, Modus Ponens, Resolution). Highlight the importance of unification and substitution. |
| Evaluation | <p>Pose a reflective question: <i>"How does inference theory for predicate calculus extend the capabilities of propositional logic?"</i></p> <p>Allow students to discuss and reflect on this question. Spend 5 minutes to evaluate students' understanding through a short quiz or discussion.</p> |



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| Lesson Plan No. 37 | Course Name: Discrete Mathematics Topic: Introduction to algebraic structures | Course No.: MCA-104 |
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| Objectives | By the end of this lesson, students will be able to: <ul style="list-style-type: none"> Define algebraic structures and their significance in mathematics. Identify the key components of an algebraic structure: sets, operations, and axioms. Differentiate between common algebraic structures such as groups, rings, and fields. |
| Teaching Aids (if any) | Whiteboard and markers |
| Teaching Development | <p>Introduction (10 minutes)</p> <p>Start with a simple question: <i>"How do numbers and operations, such as addition and multiplication, follow rules like commutativity and associativity?"</i></p> <p>Introduce the idea that such rules form the foundation of algebraic structures.</p> <p>Teaching Concepts (30 minutes)</p> <ul style="list-style-type: none"> Set: A collection of elements (e.g., integers, real numbers). Operations: Rules combining elements of the set (e.g., addition, multiplication). Axioms: Properties that operations must satisfy (e.g., associativity, identity). Types of Algebraic Structures: Semigroup, Monoid, Group, Ring and Fields. <p>Exercise (25 minutes)</p> <p>Group Activity: Provide scenarios and ask groups to identify the algebraic structure.</p> |
| Closure | <ul style="list-style-type: none"> Summarize the key concepts covered in the lesson. Confirm students' understanding and answer any remaining questions. |
| Evaluation | <p>Pose an open-ended question: <i>"Why do you think algebraic structures are essential in both pure mathematics and computer science?"</i></p> <p>Spend 5 minutes to wrap up and consolidate</p> |

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