Department of Computer Science & Technology (Cyber Security)

Details of Lesson Plan

S.No.	Particulars	Details
1.	Course Name	Introduction to Probability & Statistics
2.	Course Code	BSC-301
3.	Academic Year	2024-25
4.	Semester	3rd
5.	Number of Lesson plans	28
6.	Faculty Assigned	Dr Pallavi Sharma

Faculty Signature

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Lesson Plan

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Lesson Plan No. 1	Course Name: Introduction to Probability and Statistics Topic: GCDs with Prime Factorization	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concepts of Number Theory. b. Solve the different problems of GCDs with Prime Factorization c. Solve the problems of GCDs with the Euclidean Algorithm. d. Apply the concept of Euclidean Algorithm in day-to-day life.
Teaching Aids (if any)	a. Chalk & talk b. Group discussion

Teaching Development	**1. Introduction** (5 minutes)
	  - Ask questions
	    Is GCD and HCF same?
	    What is the GCD of 108 and 210?
	  - Introduce the concept of GCD and The Euclidean Algorithm.
	  - Talk about its usability of these concepts in day-to-day life.
	  - Different methods to find GCDs of numbers.
	  -
	
	2. Development (15 minutes)
	  a. GCD and Prime Factorization
	    - Introduce the concept of GCD and Prime Factorization.
	  b. The Euclidean Algorithm
	    -Introduce the concepts of Euclidean Algorithm and finding GCDs of numbers.
	
	3. Exercise (20 minutes) –
	    - Do various problems on finding GCDs with Prime Factorization and using Euclidean Algorithm.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	   https://www.maths.tcd.ie/pub/Maths/Courseware/374/Primality.pdf
	
	3. Homework
	  - Given some questions on GCDs to solve.
	
	Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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. 2	Course Name: Introduction to Probability and Statistics Topic: **Fundamental Theorem of Arithmetic**	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to:
	    a. Articulate the statement of Fundamental Theorem of Arithmetic and its importance.
	    b. Solve the examples based on theorem.

Teaching Aids (if any)	a. Chalk & Talk

Teaching Development	1. **Introduction** (5 minutes)
	    - Ask questions
	    - Define prime numbers.
	    - Analyze the prime factorization of 84 and explain why it is unique.
	    - Introduce the Statement of Fundamental Theorem of Arithmetic.
	    - Talk about examples.
	    - Highlight the application of theorem.
	
	2. **Development** (15 minutes)
	    a. Fundamental Theorem of Arithmetic
	      - Introduce the statement of Fundamental Theorem of Arithmetic with brief Proof.
	    b. Examples in number theory and its significance
	
	3. **Exercise** (20 minutes) –
	    -Do various theorem-based problems.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    https://www.maths.tcd.ie/pub/Maths/Courseware/374/Primality.pdf
	
	3. Homework
	
	    - Given some questions on Prime factorization with the use of this theorem.
	Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. 2. Short quiz on prime numbers and basics of number theory. Spend 5 minutes to evaluate student assimilation of the lesson contents

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Lesson Plan No. 3	Course Name: Introduction to Probability and Statistics Topic: Factorization of Integers	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to:
	   a. Articulate the concept of Factorization of Integers and the Fermat's Theorem.
	   b. Solve the numerical based on Fermat's method of Factorization.

Teaching Aids (if any)	Chalk and Talk

Teaching Development	1. **Introduction** (5 minutes)
	   - Ask questions
	     Factorize 393 and 7084
	   - Introduce the Fermat's theorem and factorize the integers.
	   - Talk about its applications in day-to-day life.
	   - Solve some numerical.
	   - Highlight the applications of concept.
	
	2. **Development** (15 minutes)
	   a. Factorization by Fermat's method
	     - Introduce the statement of Fermat's theorem and factorize the integers.
	   b. Examples.
	
	3. **Exercise** (20 minutes) –
	   - Do problems on different factorization methods and by using Fermat's numbers.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://lms.su.edu.pk/download?filename=1606645250-week-05.pdf&lesson=40143 3. Homework - Given some questions on Prime factorization with the use of this theorem. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. 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. 4	Course Name: Introduction to Probability and Statistics Topic: Linear Congruences	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to:
	    a. Introduce the concept of Congruences and linear congruences.
	    b. Articulate the properties of Congruences.
	    c. Solve the problems on Congruence and Incongruence.

Teaching Aids (if any)	Chalk and Talk

Teaching Development	1. **Introduction** (5 minutes)
	    - Ask questions
	    - What is a linear congruence?
	    - State the general form of a linear congruence.
	    - Define what it means for two numbers to be congruent modulo n.
	    - Introduce the concept of Congruences and linear Congruences.
	
	2. **Development** (15 minutes)
	    a. Introduction to Congruences and Linear Congruences.
	      - Overview of properties of Congruences and solve numerical on congruences.
	
	3. **Exercise** (20 minutes) –
	    - Do various problems based on the concepts.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	   https://nptel.ac.in/courses/111103020
	3. Homework
	
	    - Given some questions on Prime factorization with the use of this theorem.
	
	Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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. 5	Course Name: Introduction to Probability and Statistics Topic: Chinese Remainder Theorem	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to:
	    a. Articulate the concept and statement of the Chinese Remainder Theorem.
	    b. Explain the examples related to above theorem.
	    c. Solve the problems based on the theorem.
	    d. Articulate the applications of theorem.

Teaching Aids (if any)	Chalk and Talk

Teaching Development	1. **Introduction** (5 minutes)
	    - Ask questions
	    - What is the Chinese Remainder Theorem (CRT)?
	    - What are the necessary conditions for the Chinese Remainder Theorem to be applicable?
	    - Introduce the statement of Chinese Remainder Theorem and
	    - Solve various problems based on the theorem.
	    - Highlight the applications of Chinese Remainder Theorem
	
	2. **Development** (15 minutes)
	    a. Introduction to the Statement of Chinese Remainder Theorem.
	    b. Proof of CRT
	    c. Applications in solving congruences
	    d. Solve the numerical based on this theorem.
	
	3. **Exercise** (20 minutes) –
	    - Do various problems based on the Chinese Remainder Theorem.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://www.math.cmu.edu/~mradclif/teaching/127S19/Notes/ChineseRemainderTheorem.pdf 3. Homework - Given some questions based on topic. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss.

	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 6	Course Name: Introduction to Probability and Statistics Topic: System of Linear Congruences	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of System of Linear Congruences. b. Solving systems of linear Congruences by the use of Chinese Remainder Theorem. c. Applications of Linear Congruences.
Teaching Aids (if any)	Chalk and Talk

Teaching Development	1. **Introduction** (5 minutes)
	    - Ask questions
	    - What is a system of linear congruences?
	    - State the general form of a system of linear congruences.
	    - Define what it means for a system of linear congruences to have a solution.
	    - Introduce the concept of Systems of Linear Congruences
	    - Solve various problems based on Linear Congruences.
	
	2. **Development** (15 minutes)
	    a. Introduction to the Systems of Linear Congruences.
	    b. Solve the numerical problems based on systems of Linear Congruences.
	
	3. **Exercise** (20 minutes) –
	    - Do various problems based on Systems of Linear Congruences.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://math.gordon.edu/ntic/ntic/section-solve-lin-cong.html 3. Homework - Given some questions based on systems of Linear Congruences. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. 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. 8	Course Name: Introduction to Probability and Statistics Topic: Elementary theory of convex set	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concepts of Linear Programming. b. Able to understand the elementary theory of convex set.
Teaching Aids (if any)	a. Chalk & talk b. Group discussion

Teaching Development	**1. Introduction** (5 minutes)
	  - Ask questions
	    What is Linear Programming?
	    What is the standard form of LP?
	  - Talk about its usability and importance of these concepts in day-to-day life.
	  - Convex sets and its use.
	
	2. Development (15 minutes)
	  a. Linear Programming Problem
	    - Introduce the concept of LP and its importance.
	  b. The Elementary theory of convex sets
	    -Introduce the concepts of convex sets, its examples and formal definition.
	    - Talk about the properties of convex sets.
	
	3. Exercise (20 minutes)
	  - Do various problems on solving linear programming problem with the understanding of concept of convex sets.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://www.math.cuhk.edu.hk/course_builder/1920/math4230/ch1.pdf 3. Homework - Given some questions on LPP to solve. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. 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. 9	Course Name: Introduction to Probability and Statistics Topic: Formulation of LPP and its examples	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concepts of Linear Programming. b. Able to formulate the linear programming problem with the examples.
Teaching Aids (if any)	a. Chalk & talk

Teaching Development	**1. Introduction** (5 minutes)
	- Ask questions
	   What is Linear Programming?
	   What is the standard form of LP?
	- Talk about its usability and importance of these concepts in day-to-day life.
	- Provide an example of linear programming and talk about its formulation.
	
	2. Development (15 minutes)
	a. Linear Programming Problem
	   - Formulation of LP problem and its importance.
	b. Examples of LPP
	   -Introduce the concepts of linear programming and its formulation.
	   - Talk about the properties of LP and explain its examples.
	
	3. Exercise (20 minutes)
	- Do various problems on solving linear programming problem with the understanding of formulating problems.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	
	   https://www.youtube.com/watch?v=fgoaGxzwLqI
	3. Homework
	   - Given some questions on LPP to solve.
	
	Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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. 10	Course Name: Introduction to Probability and Statistics Topic: Various problems of LPP	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concepts of Linear Programming. b. Able to understand various problems like manufacturing problems, transportation problem etc in linear programming and solving them.
Teaching Aids (if any)	a. Chalk & talk

Teaching Development	**1. Introduction** (5 minutes)
	 - Ask questions
	 What is Linear Programming?
	 What is the standard form of LP?
	 - Talk about its usability and importance of these concepts in day-to-day life.
	 - Provide an example of linear programming and talk about its formulation.
	 - Talk about various problems like manufacturing related, diet problem, optimal assignment problem etc to understand LPP concept.
	
	 2. Development (15 minutes)
	 a. Linear Programming Problem in various fields
	     - Manufacturing Problems
	     - Diet Problems
	     - Optimal Assignment Problem
	     - Transportation Problems
	 b. Examples of LPP
	     -Provide the problem statement and its solution by the use of LPP.
	     - Talk about the properties of LP and explain its examples.
	
	 3. Exercise (20 minutes)
	 - Do various problems on solving linear programming problem.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://www.youtube.com/watch?v=fgoaGxzwLqI 3. Homework - Given some questions on LPP to solve. Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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. 11	Course Name: Introduction to Probability and Statistics Topic: Graphical Method of solving LPP	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Learn about the methods of solving LPP. b. Graphical Method of solving linear programming problems.
Teaching Aids (if any)	a. Chalk & talk

Teaching Development	**1. Introduction** (5 minutes)
	 - Ask questions
	   What is Linear Programming?
	   What is the standard form of LP?
	 - Talk about its usability and importance of these concepts in day-to-day life.
	 - Provide an example of linear programming and talk about its formulation.
	 - Talk about various problems of LPP.
	 - How to solve LPP?
	
	 2. Development (15 minutes)
	 a. Solving Linear Programming Problems by different methods
	   - Graphical Method
	   - Simplex Method
	 b. Examples of solving LPP
	   -Provide the problem statement and its solution by the use of graphical method.
	   - Step-by-step solution of LPP by representing it graphically and solving it by graphical method.
	
	 3. Exercise (20 minutes)
	 - Do various problems on solving linear programming problem by graphical method.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://www.youtube.com/watch?v=2EvC1v1FI2k&list=PLU6SqdYcYsfLewoQPYjgg7SMBLjSV704v&index=2 3. Homework - Given some questions on LPP to solve by graphical method. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. 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. 12	Course Name: Introduction to Probability and Statistics Topic: Simplex Method of solving LPP	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Learn about the methods of solving LPP. b. Simplex Method of solving linear programming problems.
Teaching Aids (if any)	a. Chalk & talk

Teaching Development	**1. Introduction** (5 minutes)
	- Ask questions
	  What is Linear Programming?
	  What is the standard form of LP?
	- Talk about its usability and importance of these concepts in day-to-day life.
	- Provide an example of linear programming and talk about its formulation.
	- Talk about various problems of LPP.
	- How to solve LPP?
	
	2. Development (15 minutes)
	a. Solving Linear Programming Problems by different methods
	  - Graphical Method
	  - Simplex Method
	b. Examples of solving LPP
	  -Provide the problem statement and its solution by the use of simplex method.
	  - Step-by-step solution of LPP by simplex method.
	c. Duality of LPP
	
	  - Talk about the duality of LPP and solve the problem of duality in linear programming problems.
	
	3. Exercise (20 minutes)
	  - Do various problems on solving linear programming problem by simplex method.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	
	  https://nptel.ac.in/courses/111102012
	
	3. Homework
	  - Given some questions on LPP to solve by simplex method.
	
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Evaluation	1. 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: Introduction to Probability and Statistics Topic: Introduction to Queuing theory & elements of a Queuing model	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of Queuing theory. b. Understand the elements of a Queuing model.
Teaching Aids (if any)	a. Chalk & talk

Teaching Development	**1. Introduction** (5 minutes)
	 - Ask questions
	 What is a queue?
	 What do you understand by the term "Queuing theory?
	 - Talk about its usability and importance.
	 - Examples of queuing theory in our day-to-day life, need to study queues.
	 - Talk about various problems related to queuing theory.
	 - Elements of a queuing model.
	
	 2. Development (20 minutes)
	 a. Queuing Theory
	    - Basic definition
	    - Need of studying queueing theory
	 b. Examples of queues models
	    -Provide the examples & their solutions by queuing models.
	 c. Elements of a Queuing model
	    - Talk about the ways in which the queue can be formed and its representation diagrammatically.
	
	 3. Exercise (15 minutes)
	 - Discuss various problems related to queuing theory in our daily lives.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/MODULE-4-Queueing-Theory.pdf 3. Homework - Given some questions on queuing theory to solve. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss.

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| | Spend 5 minutes to evaluate student assimilation of the lesson contents |

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Lesson Plan No. 14	Course Name: Introduction to Probability and Statistics Topic: Queuing Process and its Fundamental Structure.	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to:
	   a. Articulate the concept of Queuing process.
	   b. Understand the fundamental structure of a queuing system.

Teaching Aids (if any)	a. Chalk & talk

Teaching Development	**1. Introduction** (5 minutes)
	   - Ask questions
	      What is a queue?
	      What do you understand by the term "Queuing theory?
	   - Talk about its usability and importance.
	   - Examples of queuing theory in our day-to-day life, need to study queues.
	   - Talk about various problems related to queuing theory.
	   - Elements of a queuing model.
	
	2. Development (25 minutes)
	   a. Queuing Theory
	      - Basic definition
	      - Need of studying queueing theory
	   b. Queuing Process
	      - Basic terms related to queuing process.
	      - Transient State and Steady State.
	   c. Fundamental Structure of a Queuing System
	      - Discuss the fundamental structure of a queuing system which includes Arrival Process, Queue Discipline, Service Process: Number of Servers, Queue Capacity: System Capacity, Customer Behaviour and Performance Metrics
	
	3. Exercise (10 minutes)
	   - Discuss about various problems related to queuing theory in our daily lives.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	
	     https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/MODULE-4-Queueing-Theory.pdf
	
	3. Homework
	   - Given some questions on queuing theory to solve.
	
	Spend 5 minutes to wrap up and consolidate the learning.

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Evaluation	1. Reflective Questions (What, why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 15	Course Name: Introduction to Probability and Statistics Topic: Probability distributions in Queuing Systems	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of Queuing process. b. Understand the fundamental structure of a queuing system.
Teaching Aids (if any)	a. Chalk & talk
Teaching Development	**1. Introduction** (5 minutes) - Ask questions - What is a queue? - What do you understand by the term "Queuing theory? - What is a probability distribution? - Have you studied probability distributions before? - Talk about various problems related to queuing theory. **2. Development** (15 minutes) a. Basic terms related to queuing process. - Transient State and Steady State. b. Explain common probability distributions used in queuing systems (Poisson, Exponential, etc.). c. Discuss their characteristics and applications. **3. Exercise** (20 minutes) - Solve problems involving probability distributions in queuing. - Identify appropriate distributions for different queuing scenarios.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/MODULE-4-Queueing-Theory.pdf 3. Homework Given some questions on queuing theory to solve. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. 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. 16	**Course Name:** Introduction to Probability and Statistics **Topic:** Classification of Queuing Models (Single Server and Multi-Server)	**Course No.: BSC-301**

Objectives	At the end of the lesson, students will be able to*:*
	    a. Classify queuing models.
	    b. Differentiate between single-server and multi-server queuing models.
	    c. Analyse the characteristics of these models.

Teaching Aids (if any)	Chalk & talk

Teaching Development	**Introduction (5 minutes)**
	
	    - Ask questions:
	    - What is a single-server queuing model?
	    - What is a multi-server queuing model?
	    - Introduce the concept of queuing model classification.
	
	    a. Development (10 minutes)
	
	Explain single-server and multi-server queuing models.
	
	    • Discuss their characteristics and differences.
	    • Introduce the concept using NPTEL link: NPTEL - Queuing Models.
	      https://onlinecourses.nptel.ac.in/noc22_ma17/preview
	
	Exercise (25 minutes)
	
	    • Classify different queuing scenarios.
	    • Analyze the characteristics of single-server and multi-server models.
	    • Solve problems involving these models.

Closure	• Summarize the lesson learning outcomes and get affirmation from students.
	    • Suggested Reading: NPTEL - Queuing Models https://onlinecourses.nptel.ac.in/noc22_ma17/preview
	    • Homework: Given some questions on classification of queuing models to solve.

Evaluation	• Reflective Questions: What are the differences between single-server and multi-server models? How do we classify queuing models? • Spend 5 minutes to evaluate student assimilation of the lesson contents.

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Lesson Plan No. 17	**Course Name:** Introduction to Probability and Statistics **Topic:** Queuing Model Arrival-Departure Equations for M/M/1	**Course No.: BSC-301**

Objectives	At the end of the lesson, students will be able to: 1. Understand arrival-departure equations for M/M/1 queuing model. 2. Apply these equations to solve queuing problems. 3. Analyze the M/M/1 model.
Teaching Aids (if any)	ICT, Whiteboard, Markers

Teaching Development	**Introduction (5 minutes)**
	
	 • Ask questions:
	     o What is the M/M/1 queuing model?
	     o What do you know about arrival-departure processes?
	 • Introduce the M/M/1 model.
	
	 Development (10 minutes)
	
	 • Explain the arrival-departure equations for M/M/1 model.
	 • Discuss the assumptions and characteristics of the M/M/1 model.
	 • Introduce the concept using NPTEL link: NPTEL - M/M/1 Model.
	
	 Exercise (25 minutes)
	
	 • Solve problems using arrival-departure equations for M/M/1.
	 • Analyze the results and interpret the findings.

Closure	• Summarize the lesson learning outcomes and get affirmation from students. • Suggested Reading: NPTEL - M/M/1 Model • Homework: Given some questions on M/M/1 model to solve.
Evaluation	• Reflective Questions: What are the arrival-departure equations for M/M/1? How do we use them?

	• Spend 5 minutes to evaluate student assimilation of the lesson contents.

Lesson Plan No. 18	**Course Name:** Introduction to Probability and Statistics **Topic:** Operating Characteristics for the M/M/1 Queuing Model	**Course No.: BSC-301**

Objectives	At the end of the lesson, students will be able to: 1. Understand the operating characteristics of M/M/1 model. 2. Calculate performance measures for M/M/1. 3. Interpret the results.
Teaching Aids (if any)	ICT, Whiteboard, Markers

Teaching Development	**Introduction (5 minutes)**
	
	- Ask questions:
	  o What are operating characteristics in queuing models?
	  o Have you analyzed performance measures before?
	- Introduce the operating characteristics of M/M/1 model.
	
	Development (10 minutes)
	
	- Explain the key operating characteristics (e.g., average number of customers, average waiting time, etc.).
	- Discuss their significance and calculations.
	- Introduce the concept using NPTEL link: NPTEL - M/M/1 Operating Characteristics. https://archive.nptel.ac.in/courses/108/105/108105017/
	
	Exercise (25 minutes)
	
	- Calculate performance measures for M/M/1.
	
	  Analyze the results and interpret the findings

Closure	- Summarize the lesson learning outcomes and get affirmation from students. - Suggested Reading: NPTEL - M/M/1 Operating Characteristics https://archive.nptel.ac.in/courses/108/105/108105017/ Homework: Given some questions on operating characteristics of M/M/1 to solve.
Evaluation	- Reflective Questions: What are the operating characteristics of M/M/1? How do we calculate them? Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 19	**Course Name:** Introduction to Probability and Statistics **Topic:** Concept of non-parametric tests & its advantages over parametric tests	**Course No.: BSC-301**

Objectives	At the end of the lesson, students will be able to: 1. Understand the concept of non-parametric tests. 2. Identify the advantages of non-parametric tests over parametric tests. 3. Apply non-parametric tests to real data.
Teaching Aids (if any)	ICT, Whiteboard, Markers

Teaching Development	**Introduction (5 minutes)**
	
	• Ask questions:
	    o What are parametric tests?
	    o What do you know about non-parametric tests?
	• Introduce the concept of non-parametric tests.
	
	Development (10 minutes)
	
	• Explain the concept and importance of non-parametric tests.
	• Discuss the advantages of non-parametric tests over parametric tests.
	• Introduce the concept using NPTEL link: NPTEL - Non-Parametric Tests.
	https://onlinecourses.nptel.ac.in/noc21_ma73/preview
	
	Exercise (25 minutes)
	
	• Apply non-parametric tests to sample data.
	
	Compare results with parametric tests.

Closure	• Summarize the lesson learning outcomes and get affirmation from students. • Suggested Reading: NPTEL - Non-Parametric Tests https://onlinecourses.nptel.ac.in/noc21_ma73/preview Homework: Given some questions on non-parametric tests to solve
Evaluation	• Reflective Questions: What are non-parametric tests? What are their advantages over parametric tests? • Spend 5 minutes to evaluate student assimilation of the lesson contents.

Lesson Plan No. 20	**Course Name:** Introduction to Probability and Statistics **Topic:** Sign test for single sample and two sample problems (for paired and independent samples)	**Course No.: BSC-301**

Objectives	At the end of the lesson, students will be able to: 1. Understand the sign test for single sample and two sample problems. 2. Apply the sign test to paired and independent samples. 3. Interpret the results.
Teaching Aids (if any)	ICT, Whiteboard, Markers

Teaching Development	**Introduction (5 minutes)**
	
	• Ask questions:
	    ○ What is the sign test?
	    ○ Have you used any non-parametric tests before?
	• Introduce the sign test.
	
	Development (10 minutes)
	
	• Explain the sign test for single sample and two sample problems.
	• Discuss its applications and significance.
	• Introduce the concept using NPTEL link: NPTEL - Sign Test.
	https://onlinecourses.nptel.ac.in/noc21_ma74/preview
	
	Exercise (25 minutes)
	
	• Apply the sign test to paired and independent samples.
	• Analyze the results and interpret the findings.

Closure	• Summarize the lesson learning outcomes and get affirmation from students. • Suggested Reading: NPTEL - Sign Test https://onlinecourses.nptel.ac.in/noc21_ma74/preview • Homework: Given some questions on sign test to solve.
Evaluation	• Reflective Questions: What is the sign test? How do we apply it to single

	and two sample problems?
	• Spend 5 minutes to evaluate student assimilation of the lesson contents.

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Lesson Plan No. 21	**Course Name:** Introduction to Probability and Statistics **Topic:** Wilcoxon-Signed Rank Test	**Course No.: BSC-301**

Objectives	At the end of the lesson, the student shall be able to: • Understand the concept and application of the Wilcoxon-Signed Rank Test. • Perform the Wilcoxon-Signed Rank Test on paired data samples. • Interpret the results of the Wilcoxon-Signed Rank Test.
Teaching Aids (if any)	ICT White board, Markers

Teaching Development	**Introduction (5 minutes)**
	
	• Discuss the need for non-parametric tests in statistics.
	• Explain when and why to use the Wilcoxon-Signed Rank Test instead of a t-test.
	• Introduce the concept of ranking differences and signed ranks.
	• Mention practical applications (e.g., pre-test and post-test scores).
	
	Development (5 minutes)
	
	• Explain the steps to perform the Wilcoxon-Signed Rank Test:
	  1. Calculate the differences between pairs.
	  2. Rank the absolute differences.
	  3. Assign signs to the ranks.
	  4. Calculate the test statistic.
	• Highlight key characteristics and assumptions of the test.
	• Introduce the formal concept of the Wilcoxon-Signed Rank Test using NPTEL resources.
	  ○ NPTEL Course on Non-Parametric Tests
	  https://onlinecourses.nptel.ac.in/noc21_ma73/preview
	
	Exercise (30 minutes)
	
	• Perform several examples of the Wilcoxon-Signed Rank Test.
	• Students calculate the test statistic for given data sets.
	• Interpret the results of the tests.

Closure	• Summarize the lesson outcomes. • Ask students to reflect on when to use the Wilcoxon-Signed Rank Test. • Suggested Reading: NPTEL Course on Non-Parametric Tests

	https://onlinecourses.nptel.ac.in/noc21_ma73/preview • Assign homework on additional data sets.
Evaluation	• Reflective questions: Why use the Wilcoxon-Signed Rank Test? What does the test tell us about the data? 5 minutes of evaluation to ensure understanding

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Lesson Plan No. 22	**Course Name:** Introduction to Probability and Statistics **Topic:** Mann-Whitney U-Test	**Course No.: BSC-301**

Objectives	At the end of the lesson, the student shall be able to: • Understand the concept and application of the Mann-Whitney U-Test. • Perform the Mann-Whitney U-Test on independent data samples. • Interpret the results of the Mann-Whitney U-Test.
Teaching Aids (if any)	ICT Whiteboard, Markers

Teaching Development	**Introduction (5 minutes)**
	
	 • Explain the need for the Mann-Whitney U-Test in non-parametric statistics.
	 • Discuss the situations where the Mann-Whitney U-Test is preferred over a t-test.
	 • Mention practical applications (e.g., comparing two different groups).
	
	 Development (5 minutes)
	
	 • Explain the steps to perform the Mann-Whitney U-Test:
	    1. Combine and rank all observations.
	    2. Calculate the U statistic for each sample.
	    3. Determine the significance of U.
	 • Highlight key characteristics and assumptions of the test.
	 • Introduce the formal concept of the Mann-Whitney U-Test using NPTEL resources.
	    o NPTEL Course on Non-Parametric Tests
	
	 Exercise (30 minutes)
	
	 • Perform several examples of the Mann-Whitney U-Test.
	 • Students calculate the U statistic for given data sets.
	
	 Interpret the results of the tests

Closure	• Summarize the lesson outcomes. • Ask students to reflect on when to use the Mann-Whitney U-Test. • Suggested Reading: NPTEL Course on Non-Parametric Tests https://www.youtube.com/watch?v=ZXQnBTBEBw8 • Assign homework on additional data sets.

Evaluation	- Reflective questions: Why use the Mann-Whitney U-Test? What does the test tell us about the data? 5 minutes of evaluation to ensure understanding.

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Lesson Plan No. 23	**Course Name:** Introduction to Probability and Statistics **Topic:** Run Test	**Course No.: BSC-301**

Objectives	At the end of the lesson, the student shall be able to: • Understand the concept and application of the Run Test. • Perform the Run Test for randomness on a data sequence. • Interpret the results of the Run Test.
Teaching Aids (if any)	ICT Whiteboard and Makers

Teaching Development	**Introduction (5 minutes)**
	
	• Discuss the importance of randomness in statistical data.
	• Explain when and why to use the Run Test.
	• Mention practical applications (e.g., testing randomness in quality control).
	
	Development (5 minutes)
	
	• Explain the steps to perform the Run Test:
	   1. Define runs in the sequence.
	   2. Calculate the number of runs.
	   3. Determine the expected number of runs and its variance.
	   4. Calculate the test statistic.
	• Highlight key characteristics and assumptions of the test.
	• Introduce the formal concept of the Run Test using NPTEL resources.
	   ○ NPTEL Course on Non-Parametric Tests
	
	Exercise (30 minutes)
	
	• Perform several examples of the Run Test.
	• Students calculate the number of runs and the test statistic for given data sets.
	• Interpret the results of the tests.

Closure	• Summarize the lesson outcomes. • Ask students to reflect on when to use the Run Test. • Suggested Reading: NPTEL Course on Non-Parametric Tests https://onlinecourses.nptel.ac.in/noc21_ma73/preview

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	• Assign homework on additional data sets.
Evaluation	• Reflective questions: Why use the Run Test? What does the test tell us about the data? 5 minutes of evaluation to ensure understanding

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Lesson Plan No. 23	**Course Name:** Introduction to Probability and Statistics **Topic:** Median test and test for independence based on Spearman's rank correlation	**Course No.: BSC-301**

Objectives	At the end of the lesson, the student shall be able to: • Understand the concept and application of the Median Test. • Perform the Median Test on two or more independent samples. • Understand the concept and application of Spearman's Rank Correlation for testing independence. • Perform the Test for Independence using Spearman's Rank Correlation. • Interpret the results of both tests.
Teaching Aids (if any)	ICT Whiteboard and Makers

Teaching Development	**Introduction (5 minutes)**
	
	 • Discuss the need for the Median Test in non-parametric statistics.
	 • Explain when and why to use the Median Test and Spearman's Rank Correlation.
	 • Mention practical applications (e.g., comparing medians across groups, testing correlations).
	
	 Development (5 minutes)
	
	 • Explain the steps to perform the Median Test:
	    1. Calculate the median of all samples combined.
	    2. Create a contingency table.
	    3. Perform a chi-square test.
	 • Explain the steps to perform Spearman's Rank Correlation:
	    1. Rank the data.
	    2. Calculate the difference between ranks.
	    3. Compute the correlation coefficient.
	    4. Determine the significance.
	 • Highlight key characteristics and assumptions of both tests.
	 • Introduce the formal concepts using NPTEL resources.
	    o NPTEL Course on Non-Parametric Tests
	    o NPTEL Course on Spearman's Rank Correlation
	
	 Exercise (30 minutes)
	
	 • Perform several examples of the Median Test.

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	• Students perform the Median Test on given data sets. • Perform several examples of Spearman's Rank Correlation. • Students calculate the correlation coefficient for given data sets. • Interpret the results of both tests.
Closure	• Summarize the lesson outcomes. • Ask students to reflect on when to use the Median Test and Spearman's Rank Correlation. • Suggested Reading: NPTEL Course on Non-Parametric Tests and NPTEL Course on Spearman's Rank Correlation https://archive.nptel.ac.in/courses/111/102/111102143/ • Assign homework on additional data sets.
Evaluation	• Reflective questions: Why use the Median Test and Spearman's Rank Correlation? What do the tests tell us about the data? • 5 minutes of evaluation to ensure understanding.

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Lesson Plan No. 25	Course Name: Introduction to Probability and Statistics Topic: Stochastic Processes	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of Stochastic Processes and Markov Chains. b. Solve numerical problems on the concept of stochastic processes and Markov chains
Teaching Aids (if any)	a. Chalk and Talk
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. What is meant by Stochastic variables? - Talk about its applications and examples in day-to-day life. 2. **Development** (15 minutes) a. Discuss the concept of Stochastic Processes and Markov Chains b. Solve various numerical problems based on the topic of Transition Matrix 3. **Exercise** (20 minutes) - Do various problems on Stochastic processes and Markov chains.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading https://nptel.ac.in/courses/111102014 3. Homework - Given some questions on Stochastic processes topic to solve. Spend 5 minutes to wrap up and consolidate the learning.
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents.

Lesson Plan No. 26	Course Name: Introduction to Probability and Statistics	Course No.: BSC-301
	Topic: Transition Probability Matrix	

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of Transition probability and transition probability matrix. b. Solve numerical problems on the concept of transition matrix
Teaching Aids (if any)	a. Chalk and Talk
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. - What is meant by Stochastic process and its transition probability matrix? - What are the properties of TPM - Talk about its applications and examples in day-to-day life. 2. **Development** (15 minutes) a. Discuss the concept of Transition Probability Matrix. b. Solve various numerical problems based on the topic of Transition probability. 3. **Exercise** (20 minutes) – - Do various problems on stochastic processes and its probability matrix.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	 2. Suggested Reading
	     https://nptel.ac.in/courses/111102014
	     https://nptel.ac.in/courses/110101141
	
	 3. Homework
	 - Given some questions on Stochastic processes topic to solve.
	
	 Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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. 27	Course Name: Introduction to Probability and Statistics Topic: Markov Chains	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of first order and higher Markov Chains and n step transition probabilities. b. Solve numerical problems on the concept of higher order Markov chains and n step transition probabilities.
Teaching Aids (if any)	a. Chalk and Talk

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	  - What is meant by Markov Chains?
	  - What is the Markov property, and why is it important in the context of Markov chains?
	    How do you define a Markov chain formally?
	  - Introduce the terms formally
	
	2. **Development** (15 minutes)
	  a. Discuss the concept of higher order Markov Chains.
	  b. Solve various numerical problems based on the topic of n step transition probabilities.
	
	3. **Exercise** (20 minutes) –
	  - Do various problems on n step transition probabilities in Markov chains.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    https://nptel.ac.in/courses/111102014
	    https://nptel.ac.in/courses/110101141
	
	3. Homework
	  - Given some questions on Markov Chains topic to solve.
	
	Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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. 28	Course Name: Introduction to Probability and Statistics Topic: Steady State Condition in Markov Analysis	Course No.: BSC-301

Objectives	At the end of the lesson the student shall be able to: a. Articulate the concept of steady state condition in Markov Analysis. b. Solve numerical problems on the concept of Markov Analysis.
Teaching Aids (if any)	a. Chalk and Talk

Teaching Development	1. **Introduction** (5 minutes)
	  - Ask questions.
	  - What is meant by Markov Chains?
	  - What conditions ensure the existence of a steady-state distribution for a Markov chain?
	  - Talk about its applications and examples in day-to-day life.
	  - Introduce the terms formally
	
	2. **Development** (15 minutes)
	  a. Discuss the concept of Steady state condition in Markov Analysis.
	  b. Solve various numerical problems based on the topic of Markov Analysis.
	
	3. **Exercise** (20 minutes) –
	  - Do various problems on Steady state condition in Markov Analysis.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.
	2. Suggested Reading
	    https://nptel.ac.in/courses/111102014
	    https://nptel.ac.in/courses/110101141
	
	3. Homework
	  - Given some questions on Markov process to solve.
	
	Spend 5 minutes to wrap up and consolidate the learning.

Evaluation	1. 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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