University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT202				
Course Title	Group Theory and Probability				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3	-	2	5
Pre-requisites	Sets, relations, functions and matrices				
Course Summary	This course provides a foundational understanding of key concepts in abstract algebra and probability. It develops logical thinking and structural reasoning through the study of algebraic systems and their properties. The probability section introduces basic principles . The course encourages analytical skills and abstract thinking				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Binary operations, Groups and Subgroups**	**8**
	1	Definitions and Examples related to Binary operations. Section 2 of Text[1]	
	2	Definition, Examples and elementary properties of Groups. Section 4 of Text[1]	
II		**Cyclic groups and Permutation groups**	**10**
	3	Subgroups and Cyclic Subgroups. Section 5 of Text[1]	
	4	Elementary properties and structure of cyclic groups (Proofs of 6.3, 6.10, 6.14 can be omitted). Section 6 of Text[1]	

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Module	Unit	Contents	Hrs
	5	Permutation groups and Cayley's Theorem (without proof). Section 8 of Text[1]	
III		**Probability and statistics**	**9**
	6	Probability and sample space: Definition and examples. Chapter 15: Section 1 and 2 of Text[2]	
	7	Probability theorems. Chapter 15: Section 3 of Text[2]	
	8	Random Variables.Chapter 15: Section 5 of Text[2]	
IV		**Probability Distributions**	**9**
	9	Continuous Distribution. Chapter 15: Section 7 of Text[2]	
	10	Binomial Distribution (Omit joint distribution) . Chapter 15: Section 6 of Text[2]	
	11	Normal Distribution . Chapter 15: Section 8 of Text[2]	
V		**Suggestions for the teacher designed module**	**9**
	12	Isomorphic binary structures. Section 3 of Text[1]	
	13	Orbits, cycles and the Alternating Groups, Proof of Cayley's theorem. Section 9 of Text[1]	
	14	Poisson distributions. Chapter 15: Section 9 of Text[2]	

Practical sessions and examinations – 30 hours

All the topics mentioned above can be used for practical sessions using SageMath software. Some useful resources for solving these problems using the SageMath software are given against each problem/type of problem.

1. Define congruence groups and list the elements in them

2. Perform various operations in the congruence groups

3. Finding inverse of elements in congruence groups

4. Prepare a group table of the congruence groups $\mathbb{Z}_n$ (for some selected values of n)

5. Compute symmetric groups, and perform operations among elements in them.

6. Create Cayley table of selected groups.

7. Define a group, find the cyclic group generated by an element in it.

8. Problems involving continuous distributions.

9. Problems involving binomial distribution

10. Problems involving normal distributions

A record should be maintained with the above (or problems related to the topics in the syllabus) 7 problems from the main topics/teacher designed topics. Each problem in the record must have a description of the problem, algorithm (step by step procedure),

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commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Textbook

1. J B Fraleigh, A first course in abstract algebra, 7th Edn, Pearson, 2013.

2. M L Boas, Mathematical methods in physical sciences, 3rd Edn, John Wiley and Sons, 2006.

References

1. Joseph. A. Gallian, Contemporary Abstract Algebra, Eighth Edition, Brroks/cole Cengage Learning, 2012.

2. I. N. Herstein, Topics in Algebra, Second Edition, Wiley, 2006.

3. Michael Artin, Algebra, Second Edition, Pearson Education, 2023.

4. Sheldon Ross, A first course in probability, 5th Edn, Prentice Hall, 1998.

5. Ajit Kumar, Vikas Bist, Group Theory : An expedition with SageMath, Narosa Publications, New Delhi 2021

6. Group Theory and Sage, Online tutorial, https://doc.sagemath.org/html/en/thematic_tutorials/group_theory.html

7. Probaility : Sage 9.4 Reference Manual https://doc-gitlab.sagemath.org/pdf/en/reference/probability/probability.pdf

8. Probability Distributions : SageMath documentation https://doc.sagemath.org/html/en/reference/probability/sage/probability/probability_distribution.html
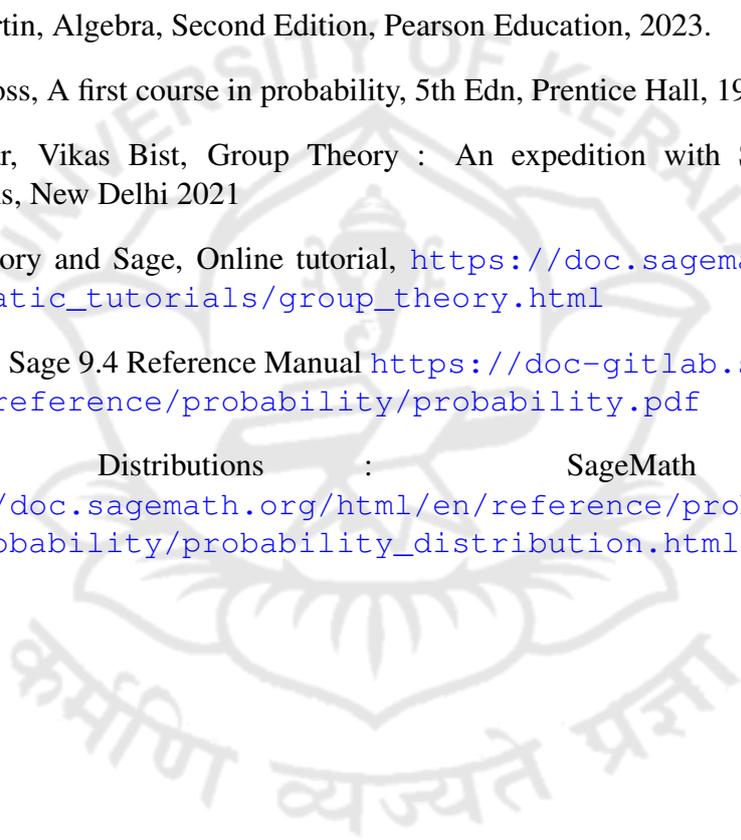
Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Define and work with binary operations and recognize isomorphic structures.	PO 2, PSO1, 2,3	U, Ap	C, P	L	
CO 2	Understand the structure and properties of groups, subgroups, and cyclic groups.	PO1, PSO1, 2,3	U	F,C	L	
CO 3	Apply group-theoretic concepts to permutation groups and prove results like Cayley's Theorem	PO2, PSO1, 2,3	Ap, An	P, C	L	
CO 4	Explain the basic principles of probability and solve problems involving random variables.	PO2, PSO1, 2,3	U, Ap	F,C	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	3	-	-	-	-	-	-
CO4	3	2	3	-	-	-	-	3	-	-	-	-	-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar

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- Midterm Exam

- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓

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