FIRST SEMESTER 2020-21
COURSE HANDOUT

Date: 17.08.2020

In addition to part - I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

COURSE NO. : MATH F 421
COURSE TITLE : Combinatorial Mathematics
INSTRUCTOR IN CHARGE : KRISHNENDRA SHEKHAWAT

COURSE DESCRIPTION : Advanced theory of permutation and combinations, counting functions, theory of partitions, Ramsey theorem, Mobius functions, permutation groups, Polya's counting, combinatorial design and enumeration of graphs.

SCOPE and OBJECTIVES: Combinatorics is often described briefly as being about counting, and indeed counting is a large part of combinatorics. As the name suggests, however, it is broader than this: it is about combining things. Questions that arise include counting problems:

"In how many ways can these elements be combined?"

But there are other questions, such as whether a certain combination is possible, or what combination is the "best" in some sense.

This course presents the different methods to solve the counting problems. It also demonstrates that how some of these methods can be used for graph counting.

TEXT BOOK:

Richard A. Brualdi, Introductory Combinatorics, Pearson, 4th Edition 2008.

REFERENCE BOOKS:

R1. Alan Tucker, Applied Combinatorics, John Wiley & Sons, 6th Edition, 2012.

R2. V. Krsihnamurthy, Combinatorics Theory and Applications, East-West Press Pvt. Ltd. 1985.

R3. Miklos Bona, Introduction to Enumerative Combinatorics, Tata McGraw-Hill, 2007.

5. Course Plan:

Module No.	Lecture Session	Reference (Sections)	Learning outcomes
1. General Counting Methods For Arrangements And Selections	**L1** Introduction to Combinatorics	Chapter 1	Familiarize with Combinatorics and Understanding Counting Principles
	L2-L3 Two Basic Counting Principles	Section 3.1	
	L4-L6 Arrangements, Selections and Distributions	Sections 3.2, 3.3, 4.1, 4.3	
	L7-L8 Binomial Identities	Sections 5.1-5.3	
	L9-L11 Pigeonhole Principle and Ramsey Theorem	Chapter 2	
2. Generating Functions	**L12** Generating Functions and Coefficients	Sections 7.4-7.7	Introducing Generating Functions as a Mathematical Model for Counting Problems
	L13-14 Partitions and Summation	Sections 6.3, 6.5 (R1)	
	L15-17 Products and Composition of Generating Functions	Sections 3.3-3.4 (R3)	
3. Recurrence Relations	**L18** Recurrence Relation Models	Section 7.1	Introducing Recurrence relations as the simplest way to solve Counting Problems
	L19 Solution of Recurrence Relations	Sections 7.2, 7.3	
	L20 Solutions with Generating Functions	Section 7.5	
4. Inclusion–Exclusion	**L21** Counting with Venn Diagrams	Section 8.1 (R1)	Introducing Inclusion–Exclusion Formula for solving more complex counting problems
	L22-L24 Inclusion–Exclusion Formula	Section 6.1	
	L25-L26 Restricted Positions and Rook Polynomials	Sections 6.4, 6.5	
5. Counting Graphs	**L27- L28** Counting Trees and Forests	Sections 5.1-5.3 (R3)	Introducing the relation between graph theory and combinatorics
	L29- L31 Graphs and Functions	Section 5.4 (R3)	
	L32- L34 Plane Trees	Section 5.5 (R3)	
	L35- L37 Graphs on Colored Vertices	Section 5.6 (R3)	
	L38-L40 Graphs and Generating Functions	Section 5.7 (R3)	

6. Evaluation Scheme:

	Evaluation Components	Weightage (Marks)	Dates
1	Test 1	15%	10.09.20 –20.09.20 (During scheduled class hour)
2	Test 2	15%	09.10.20 –20.10.20 (During scheduled class hour)
3	Test 3	15%	10.11.20 –20.11.20 (During scheduled class hour)
4	Quizzes/Assignments	20%	To be Announced Later
5	Comprehensive Exam	35%	04.12.20

7. Chamber Consultation Hour: To be announced in the class.

8. Notices: NALANDA web-site would be used to post course material as well as notices.

9. Makeup: Prior permission is needed for makeup; makeup will only be given if sufficient evidence is available for not being able to appear for Tests/Compre. **Quizzes will not have any make-ups.**

10. Note (if any):

Krishnendra Shekhawat
Instructor-in-charge