Lahore University of Management Sciences

CS 210 – Discrete Mathematics

Fall 2023-24

COURSE DESCRIPTION
This course covers the mathematical foundations of computer science. The aim is to introduce the students to the fundamental techniques of discrete mathematics, which may be employed in a variety of mathematical disciplines, including fields in theoretical computer science, such as, algorithms, data structures and complexity theory. An introduction to logic, proof techniques, sets, functions, and relations is made, along with an initiation to combinatorics, basic graph and tree structures. A very brief introduction to number theory and discrete probability is made. Problems are formed mathematically and solved using available tools and techniques.

Course Distribution	
Core	Yes
Elective	No
Open for Student Category	Sophomore
Close for Student Category	None

COURSE PREREQUISITE(S)	
●	Calculus-I, or Calculus with Theory

Instructor	Malik Jahan Khan
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Course URL (if any)	lms.lums.edu.pk

Course Basics				
Credit Hours	4			
Lecture(s)	Nbr of Lec(s) / Week	2	Duration	1 hour and 50 minutes
Recitation/Lab (per week)	Nbr of Lec(s) / Week		Duration	
Tutorial (per week)	Nbr of Lec(s) / Week		Duration	

Course Teaching Methodology (Please mention following details in plain text)

1. In-class problem sets (LMS based) will be uploaded with (almost) every lecture:
    a. An LMS problem sheet will be uploaded, students will have to write answers to all questions there.
    b. These problem sets will be embedded into lecture slides (will not be uploaded as stand-alone documents, unless otherwise stated).
    c. Their answers will be in the lectures; this is essentially the analog of class interactions. These will be counted as attendance.
    d. Answers on them will not be evaluated (but counted); the follow-up problem set will have questions very similar to these problems.
    e. These sheets will serve as students-built summary/notes of the lectures:
2. Lecture Follow-up problem-sets (generally MCQ's/ (very) short questions for each topic)
    a. These will be graded and will contain problems about applications of lecture material.
    b. These problems will be very similar to those on long quizzes and final exams.
3. Three to four Long Quizzes and a Final Exam with dates/timelines and topics will be announced. These will be timed assessments and detailed policy about how they will be conducted will be announced in due time.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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PEO-01	Demonstrate excellence in profession through in-depth knowledge and skills in the field of computing
PEO-02	Engage in continuous professional development and exhibit a quest for learning
PEO-03	Show professional integrity and commitment to societal responsibilities

COURSE OBJECTIVES	
1.	To equip students with knowledge of basic discrete structures such as sets, functions, relations etc
2.	To prepare students for making and proving precise and logical statements, such as arguing about correctness or runtime of an algorithm
3.	To train students in counting discrete structures and elementary discrete probability
4.	To introduce students to techniques for modeling computational problems by discrete structures such as graphs and trees

COURSE LEARNING OUTCOMES (CLOs)	
CLO1	Understand basic principles of discrete mathematics and apply them in applied settings
CLO2	Reason mathematically about basic discrete structures and data types
CLO3	Be able to understand and synthesize elementary proof

CLO	CLO Statement	Bloom's Cognitive Level	PLOs/Graduate Attributes (Seoul Accord)
CLO1	Apply these principles in applied settings	C5	PLO4, PLO5
CLO2	Reason mathematically about basic discrete structures and data types	C3, C4	PLO2, PLO3
CLO3	Be able to understand and synthesize elementary proof	C5, C6	PLO2, PLO3

Grading Breakup and Policy (Tentative)

Assessment	**Weight (%)**	**Related CLOs**	**ACM Recommended Disposition**
In-Lecture Problem Sets	10%	CLO1 – CLO3	D3, D4, D7, D9
Lecture Follow-up Problem Sets	20%	CLO1 – CLO3	D3, D4, D7, D9
Long Quizzes	45% (3 or 4, each of ~30-60 minutes long quizzes)	CLO1 - CLO63	D4, D7, D9
Final Examination	25% (1 final exam, will cover the whole course)	CLO1 -CLO3	D4, D7, D9

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Examination Detail	
Midterm Exams	Yes/No: No
Final Exam	Yes/No: Yes

COURSE OVERVIEW

Week/ Lecture/ Module	Topics	Recommended Readings	Objectives/ Application	Related CLOs	ACM Computing Knowledge Landscape
1	Introduction, motivation, Logic,	Slides, Section 1.1 – 1.4		CLO1 – CLO3	CK3.2, CK5.6, CK6.2
2	Logical Equivalence, Predicate	Slides, Section 1.1 – 1.4		CLO1 – CLO3	CK3.2, CK5.6, CK6.2
3	Predicate, Sets	Slides, Section 1.1 – 1.4, Section 2.1-2.2		CLO1 – CLO3	CK3.2, CK5.6, CK6.2
4	Sets, Functions	Slides, Section 2.1 – 2.2, 2.3		CLO1 – CLO3	CK5.6, CK5.4
5	Functions, Sequence and Sums	Slides, Section 2.3 – 2.4		CLO1 – CLO3	CK5.6, CK5.4, CK2.4
6	Proofs,	Slides, Section 1.5 – 1.7		CLO1 – CLO3	CK4.1, CK5.6
7	Proofs, Induction,	Slides, Section 1.5 – 1.7, Chapter 4		CLO1 – CLO3	CK4.1, CK5.6
8	Induction, recurrence relations, Cardinality	Slides, Section Chapter 4		CLO1 – CLO3	CK4.1, CK5.6
9	Relations, Partial Orders, Basic Counting,	Slides, Chapter 8, Section 5.1 – 5.5		CLO1 - CLO3	CK4.1, CK5.6, CK2.4
10	Advanced counting	Slides, Section 7.1 – 7.2		CLO1 – CLO3	CK2.4, CK5.3
11	Binomial theorem and Pascal triangle Graphs & Trees	Slides, Section 7.5,		CLO1 – CLO3	CK2.4, CK5.3, , CK5.6
12	Graphs and Trees	Slides, Chapter 9,		CLO1 – CLO3	CK5.3, , CK5.6
13	Graphs and Trees & Number Theory	Slides, Section 10.1- 10.2, 10.4-10.5		CLO1 – CLO3	CK5.3, , CK5.6, CK2.1
14	Number Theory and Cryptography (RSA)	Slides , Section 3.4 – 3.7		CLO1 – CLO3	CK5.3, , CK5.6, CK2.1

Textbook(s)/Supplementary Readings

1. **Textbook: R. H. Rosen, Discrete Mathematics and its Applications, 6th Edition, McGraw-Hill (or any other edition)**
2. Optional reading: J. Matousek & J. Nesetril, Invitation to Discrete Mathematics
3. Optional reading: Laszlo Lovasz & Jozsef Pelikan, Discrete Mathematics: Elementary and Beyond.

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Assignment Details:

Sr#	Assignment Title	Assignment Description	Topics Covered	Description of skills, tools, platform, etc. (e.g., Programming in C/C++, MS Visual Studio, Windows/Linux)	Proposed Duration

Appendix A
Bloom's Taxonomy

BLOOM's TAXONOMY*	
1 - Remember 2 - Understand 3 - Apply 4 - Analyze 5 - Evaluate 6 - Create	• Recall facts and basic concepts • Explain ideas or concepts • Use information in new situations • Draw connection among ideas • Justify a stand or decision • Produce new or original work

https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Appendix B
ACM Dispositions Table - I

CM Dispositions			
Element	**Elaboration**	**Element**	**Elaboration**
D1 Adaptable: D2 Collaborative: D3 Inventive: D4 Meticulous: D5 Passionate: D6 Proactive:	Flexible; agile, adjust in response to change Team player; willing to work with others Exploratory; Look beyond simple solutions Attentive to detail; thoroughness, accurate Conviction, strong commitment, compelling With initiative, self-starter, independent	D7 Professional: D8 Purpose-driven: D9 Responsible: D10 Responsive: D11 Self-directed:	Professionalism, discretion, ethical, astute Goal driven, achieve goals, business acumen Use judgment, discretion, act appropriately Respectful; react quickly and positively Self-motivated, determination, independent

ACM Dispositions Table - II

Class Assessments and Proposed Dispositions												
Assessment Type	**D1 Adaptable**	**D2 Collaborative**	**D3 Inventive**	**D4 Meticulous**	**D5 Passionate**	**D6 Proactive**	**D7 Professional**	**D8 Purpose-driven**	**D9 Responsible**	**D10 Responsive**	**D11 Self-directed**	**Included**
Quiz				✓			✓		✓			Yes
Assignment-Individual			✓	✓			✓		✓			Yes
Assignment-Group		✓	✓	✓			✓		✓	✓		Yes
Project- Individual	✓		✓	✓	✓	✓	✓	✓	✓		✓	Yes
Project- Group	✓	✓	✓	✓	✓	✓	✓	✓	✓			Yes
Presentation-Individual				✓			✓		✓	✓	✓	Yes
Presentation- Group		✓		✓			✓		✓	✓		Yes
Labs- Individual			✓	✓			✓		✓			Yes
Labs- Group		✓	✓	✓			✓		✓	✓		Yes
Exams				✓			✓		✓			Yes
Included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

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Appendix C

ACM Computing Knowledge Landscape Table

ACM Computing Knowledge Landscape (CK)			
1. Users and Organizations	CK1.1: Social Issues and Professional Practice CK1.2: Security Policy and Management CK1.3: IS Management and Leadership CK1.4: Enterprise Architecture CK1.5: Project Management CK1.6: User Experience Design	**4. Software Development**	CK4.1: Software Quality, Verification and Validation CK4.2: Software Process CK4.3: Software Modeling and Analysis CK4.4: Software Design CK4.5: Platform-Based Development
2. Systems Modeling	CK2.1: Security Issues and Principles CK2.2: Systems Analysis & Design CK2.3: Requirements Analysis and Specification CK2.4: Data and Information Management	**5. Software Fundamentals**	CK5.1: Graphics and Visualization CK5.2: Operating Systems CK5.3: Data Structures, Algorithms and Complexity CK5.4: Programming Languages CK5.5: Programming Fundamentals CK5.6: Computing Systems Fundamentals
3. Systems Architecture and Infrastructure	CK3.1: Virtual Systems and Services CK3.2: Intelligent Systems (AI) CK3.3: Internet of Things CK3.4: Parallel and Distributed Computing CK3.5: Computer Networks	**6. Hardware**	CK6.1: Architecture and Organization CK6.2: Digital Design CK6.3: Circuits and Electronics CK6.4: Signal Processing