CS/MATH 113 Discrete Mathematics

3+0 credits, Spring 2022, Habib University

"Computer science is no more about computers than astronomy is about telescopes."
– Edsger Dijkstra

"All models are wrong, but some are useful." – George Box

Instructors:	Muhammad Qasim Pasta, Rameez Ragheb, , Waqar Saleem (lead), Mohammad Shahid Shaikh
RA:	Talha Amin
TAs:	TBD
Course sites:	LMS (Canvas), Yammer, Live Syllabus
Course Prerequisites:	*None*
Software Prerequisites:	LaTeX, Zoom, a PDF viewer, a modern web browser
Hardware Prerequisites:	Computer with mic, camera, and Internet connection, capable enough to run Zoom
Content Area:	This course is part of CS Foundation. It is required for both a major and minor in CS. For other students, it can be counted as either a Free Elective, University Elective, SSE Elective, CS Elective, or CS requirement.
Campus Safety Policy:	Please read the current campus safety policy and protocols if the classes are in-person.

1 Rationale

Computer Science is the study of computation performed inevitably on discrete machines. Modeling and analysis of these computations require formal methods to reason about them as well as a mathematics that deals with discrete events and entities. In addition, computation follows a certain logic. Understanding this logic helps to not only understand computation but to prove properties of algorithms like their complexity and correctness.

This course is primarily an exercise in proofs. After covering some of the logic required to perform proofs, we study various discrete entities and techniques which are common in the design and analysis of algorithms. When studying these entities, our aim is to gain sufficient familiarity with them so as to prove their various properties. As such, this course equips you with essential mathematical tools that they will encounter in future Computer Science courses. It develops a capacity for formal mathematical manipulation and abstract thought, both of which are essential for the successful pursuit of Computer Science.

2 Course Aims and Outcomes

2.1 Course Objectives

This course aims to:

- develop a capacity for reading and writing mathematical proofs,
- introduce various discrete structures and techniques,

- emphasize precision in thought and in writing through rigorous mathematical notation, and
- develop a capacity for abstract thought necessary for the study of Computer Science.

2.2 Course Learning Outcomes (CLOs)

Course Learning Outcomes (CLOs) describe your knowledge, skills, and abilities on successful completion of a course. By the end of this course, you will achieve the following outcomes at the indicated learning levels.

Course Learning Outcome (CLO)	**1**	correctly solve problems related to propositional and predicate logic	Cog-4
	2	correctly solve problems related to sets, relations, and functions	Cog-4
	3	correctly model suitable problems using graphs and combinatorics and apply known theorems on the models	Cog-4
	4	correctly apply proof techniques to prove mathematical statements	Cog-4
	5	fruitfully collaborate on the solution, research, and presentation of problems, proofs, and techniques related to the above topics	Aff-3

2.3 Program Learning Outcomes (PLOs)

Program Learning Outcomes (PLOs) describe your knowledge, skills, and abilities at the time of graduation. Shown below is the level of emphasis that each of the CLOs places on specific PLOs of the Computer Science program.

			CLO				
			1	**2**	**3**	**4**	**5**
Program Learning Outcome (PLO)	**1**	Analysis: analyze a given situation and reduce it to one or more problems that can be solved via computer intervention.	25%	25%	25%	25%	
	5	Tools: work with the latest tools that support development, e.g., IDE's, version control systems, debuggers, profilers, and continuous build systems.	20%	20%	20%	20%	20%
	6	Self-learning: research, learn, and apply requirements needed to implement a solution for a given high level problem	25%	25%	25%	25%	
	8	Communication and Teamwork: work effectively in inter-disciplinary teams.					100%

- CLOs 1 through 4 develop analysis skills (PLO 1) but lack computer implementation.
- The assessments for CLOs 1 through 5 require working with a formal document preparation system and a version control system (PLO 5).
- You will self-learn (PLO 6) the appropriate features of the above tools.
- All assessments are attempted in teams (PLO 8) and team work is assessed.

3 Format and Procedures

This is a highly theoretical course. You are encouraged to be attentive in lectures, do all assessments in a timely manner, and to stay abreast of class discussions by reading the corresponding

sections of the book. The instructors will make all efforts to closely follow the course textbook so that you have a ready reference.

This is a 3 credit hour course. The rule of thumb for out-of-class time for a course is at least 2 hours of work outside class for every credit hour. In the previous iteration of this course, most students reported spending between 4 and 6 hours per week outside class. This may vary based on your comfort with mathematics and capacity to absorb and apply new ideas.

You must attend your weekly recitation which will provide deeper insight into the topics covered that week through hands-on practice.

Medium of Instruction This semester is foreseen to be volatile in terms of transition between on-site and online. In-person classes remain the preferred option for us, but we will have to adapt to any situation that unfolds. You will be kept up to date on changing mediums of instruction.

Time Journal You are encouraged to maintain a journal to record the time that you spend on this course. This includes the time you spend watching asynchronous videos, attending live sessions, doing any background work, attempting the homework, filling the weekly feedback form, completing any other required forms, and so on. In short, any activity that you perform related to this course.

Consultation Please utilize the consultation hours of course staff in order to discuss course related matters and queries.

Course Material All course resources (video recordings, reference books, articles and all other support material) will be made available through the course site on LMS.

Teamwork Homework assignments are attempted in teams. You will have to submit feedback on your team for each homework.

Feedback Your feedback helps us improve. This offering benefits from the feedback of students before you, and your feedback will help us improve this course for you and future students. You will be asked for feedback at various points in the semester.

Viva Submissions may be followed up by a viva of the team by course staff. The viva will be called as necessary and need not apply to all groups or all assignments. The outcome of the viva will contribute to the grading of the submission.

Punctuality Please respect deadlines. Submit your work by the indicated time. Incomplete work will receive partial credit. Late work will not be accepted or graded. Please arrange with your instructor beforehand if you are unable to meet a deadline.

Timely feedback You are entitled to receive feedback on your submissions within 2 weeks. Please remind your instructor in case they are delayed.

Contesting marks Concerns regarding a score will be entertained by the respective instructor up to a week after the release of the score. Concerns raised later will not be entertained.

Grace marks Requests for grace marks for whatever reason will not be entertained and each such request will result in a penalty of 1% from the overall score.

Behavior You are expected to maintain a behavior befitting Yohsin and acknowledging the classroom as a place of learning, exploration, and experimentation. The University's standard policies on attendance, inclusivity, office hours, and academic integrity apply in this course. These are described in later sections below.

3.1 Engagement, Netiquette, and Participation

People, not boxes In order to promote a healthy class environment, please keep your camera on during any online course meetings. In case of extenuating circumstances that prevent you from doing so, you must communicate them to me beforehand over Canvas.

Names Please make sure that your name on Zoom is the same as it appears on PeopleSoft.

Communication If you need to send a digital message to course staff for course matters, please use Canvas messaging *only*. Messages sent otherwise may get lost. Allow up to 2 working days for a response, after which you may send a reminder.

Awareness All official course communication will take place over LMS. It is your responsibility to stay up to date with it.

4 Course Requirements

This course requires comfort with mathematics. You will encounter topics that are new and challenging and will be required to absorb and apply them. You may also encounter some familiar topics but their treatment in this course may be new to you.

You are also required to have the capacity to self learn details of related tools, e.g. LaTeX and GitHub. You are highly encouraged to utilize the consultation hours of the course staff for any course discussion.

Course textbook

- *Discrete Mathematics and Its Applications (7th edition)*, by Kenneth H. Rosen.

Recommended supplementary texts

- *Mathematics for Computer Science, by Eric Lehman*, F Thomson Leighton, and Albert R Meyer.
- *Discrete Math for Computer Science Students*, by Ken Bogart, Scot Drysdale, and Cliff Stein.
- *Discrete and Combinatorial Mathematics: An Applied Introduction*, by Ralph Grimaldi.
- *Concrete Mathematics: A Foundation for Computer Science*, by Ronald Graham, Donald Knuth, and Oren Patashnik.

5 Assessments and Grading

The table below shows the assessments that you will attempt in this course, along with the weightage of each for your final score. The university's standard mapping for scores to grades is also shown.

Assessment	Weightage
Homework assignments (4)	30%
Quizzes (many, n-2 weeks)	30%
Midterm exam	10%
Final exam	20%
Weekly Feedback (n-2)	5%
Weekly Recitation	5%

Grade	Points	Percentage
A+	4.00	[95-100]
A	4.00	[90-95)
A-	3.67	[85-90)
B+	3.33	[80-85)
B	3.00	[75-80)
B-	2.67	[70-75)
C+	2.33	[67-70)
C	2.00	[63-67)
C-	1.67	[60-63)
F	0.00	[0-60)

The assessments provide you practice and help you estimate your grasp of the course content so far. By challenging you to think more deeply about course topics, they are also an excellent means of learning. Different assessments have different duration, scope, and weightage. Quizzes consist of short and direct problems on recently covered topics. Homework assignments are available for longer and provide you the opportunity to collaboratively solve challenging problems that span multiple topics. Exams test your grasp of course content in a controlled environment. Students tend to find exams stressful but if you stay on top of your quizzes and homework, the exam will not pose much of a challenge.

The weekly feedback invites you to reflect on the week's learning and share your current state in the course with us. Recitations provide you hands-on practice with current course topics.

The mode of these assessments may vary depending on the prevailing status of classes at the time. Generally, the following platforms and systems will come into play: Canvas, GitHub, LaTeX. Exams may be held as oral vivas or written/typed submissions. Such details will be finalized and shared closer to the dates.

5.1 Mapping of Assessments to Course Learning Outcomes

This course's assessment instruments are homework assignments (4), quizzes (many), and two exams. This is how they relate to the Course Learning Outcomes.

	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
Assignment 1		1			1
Assignment 2	1			1	1
Assignment 3		1		1	1
Assignment 4			1	1	1
Quizzes	1	1	1	1	
Midterm exam	1	1		1	
Final exam	1	1	1	1	

6 Attendance

You are expected to watch any pre-recorded sessions and attend all classes (on-site or online). Attendance will be formally recorded on PeopleSoft. We understand that life happens and you may sometimes be unable to attend. A slack of 15% is provided, i.e. you may miss up to 15% of the classes. Missing any more is tantamount to an irreparable loss in learning for the course, and you will be automatically dropped. When using Zoom, make sure that your Zoom name matches your name on PeopleSoft. Otherwise, we may not be able to mark your attendance.

7 Learning for all

We understand that our members represent a rich variety of backgrounds and perspectives. Habib University is committed to providing an atmosphere for learning that respects diversity. While working together to build this community we ask all members to:

- share their unique experiences, values and beliefs
- be open to the views of others
- honor the uniqueness of their colleagues
- appreciate the opportunity that we have to learn from each other in this community
- value each other's opinions and communicate in a respectful manner
- keep confidential discussions that the community has of a personal (or professional) nature
- use this opportunity together to discuss ways in which we can create an inclusive environment in this course and across the Habib community

7.1 Accommodation

In compliance with the Habib University policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require. Requests for academic accommodations are to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. You are encouraged to register with the Office of Academic Performance to verify your eligibility for appropriate accommodations.

8 Student hours

Students hours are scheduled and shared via various means including LMS and by Registrar Office. During these hours, course staff is available to answer questions or provide additional help related to the course. Please use this time to your benefit.

9 Academic Integrity

Each student in this course is expected to abide by the Habib University Student Honor Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work.

For this course, collaboration is allowed with your buddy in the following instances: **homework assignments**. Always attribute any external sources.

Scholastic dishonesty shall be considered a serious violation of these rules and regulations and is subject to strict disciplinary action as prescribed by Habib University regulations and policies. Scholastic dishonesty includes, but is not limited to, cheating on exams, plagiarism on assignments, and collusion.

PLAGIARISM Plagiarism is the act of taking the work created by another person or entity and presenting it as one's own for the purpose of personal gain or of obtaining academic credit. As per University policy, plagiarism includes the submission of or incorporation of the work of others without acknowledging its provenance or giving due credit according to established academic practices. This includes the submission of material that has been appropriated, bought, received as a gift, downloaded, or obtained by any other means. Students must not, unless they have been granted permission from all faculty members concerned, submit the same assignment or project for academic credit for different courses.

CHEATING The term cheating shall refer to the use of or obtaining of unauthorized information in order to obtain personal benefit or academic credit.

COLLUSION Collusion is the act of providing unauthorized assistance to one or more person or of not taking the appropriate precautions against doing so.

All violations of academic integrity will also be immediately reported to the Student Conduct Office.

You are encouraged to study together and to discuss information and concepts covered in the lecture with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e-mail, an e-mail attachment file, a diskette, or a hard copy.

Should copying occur, the student who copied work from another student and the student who gave material to be copied will both be in violation of the Student Code of Conduct.

During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Penalty for violation of this Code can also be extended to include failure of the course and University disciplinary action.

10 Week-wise Schedule

Below is a tentative schedule of topics subject to course progress. The week number and the date for each lecture is indicated. The readings specify section numbers in the course textbook, *Discrete Mathematics and Its Applications (7th edition)*, by Kenneth H. Rosen.

Please consult the Live Syllabus for up-to-date information.

Week	**Topics**	**Readings**	**Assessments/Notes**
1. 10–14 Jan	Introduction to the course. Sets	2.1	Teams assigned
2. 17–21 Jan	Sets	2.1, 2.2	HW 1 out, Quizzes
3. 24–28 Jan	Logic	1.1, 1.2	Quizzes
4. 31 Jan–4 Feb	Logic	1.3, 1.4	HW 1 due, Quizzes
5. 7–11 Feb	Logic	1.4, 1.6	HW 2 out, Quizzes
6. 14–18 Feb	Proofs	1.7, 1.8	Quizzes
7. 21–25 Feb	Relations	9.1, 9.3	HW 2 due, Quizzes
8. 28 Feb–4 Mar	Relations	9.4–9.6	Quizzes
9. 7–11 Mar	Functions	2.3	HW 3 out, Quizzes
10. 14–18 Mar	Functions	2.3	Quizzes
21–25 Mar	Conference Week		
11. 28 Mar–1 Apr	Graphs	10.1, 10.2	Quizzes
12. 4–8 Apr	Graphs	10.2, 10.3	HW 3 due, Quizzes
13. 11–15 Apr	Graphs	10.4, 10.5	HW 4 out, Quizzes
14. 18–22 Apr	Combinatorics	6.1, 6.2	Quizzes
15. 25–29 Apr	Combinatorics	6.3, 6.4	HW 4 due, Quizzes
Exam Period			Final Exam

Quizzes may be dropped some weeks depending on other concurrent course work at the time.