Habib University
shaping futures

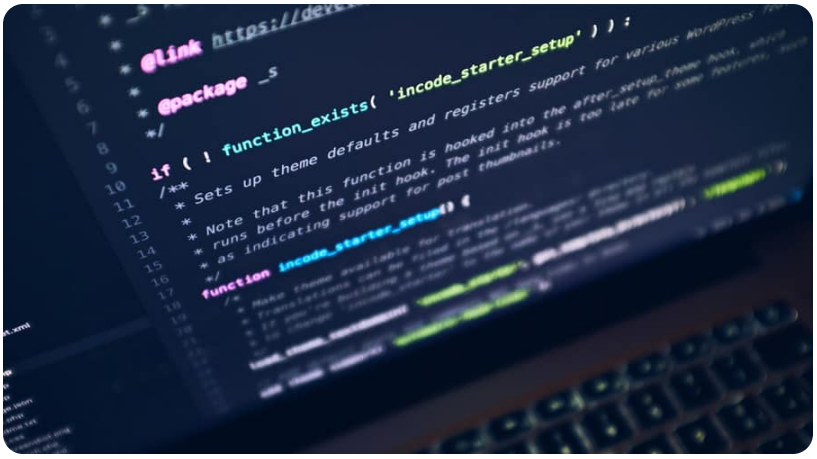
Competitive Programming

CS 3XX1 WS
Blueprint Term – Fall 2023

"First solve the problem, then write the code." - John Johnson

"Confusion is part of programming." - Felienne Hermans

"You might not think that programmers are artists, but programming is an extremely creative profession. It's logic-based creativity." - John Romero



Course Information

Course Prerequisites: None
Hardware/Software Prerequisites (if any): a LaTeX compiler, a recent C++ compiler, or any code editor with at least two languages, a computer with a mic, camera, and internet connection.
Content Area: This course fulfills the requirements of a CS Elective or a Free elective.

Instructor Information

Instructor: Waqar Saleem
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Office Hours: NA

Course Description

Programming competitions have become increasingly popular over the years, with many participants, both professional and amateurs, competing for recognition and prizes. Competitive programming has become a global phenomenon, with contests and competitions held regularly in various countries. These competitions involve solving algorithmic problems within a specified amount of time, typically a few hours, designed to test the participants' problem-solving and programming skills under time pressure.

Competitive Programming provides a fun setting for algorithmic problem-solving and computer programming. Often conducted as a team sport, it is a valuable tool for improving programming skills, particularly among undergraduate students in computer science programs. Therefore, the skills required for competitive programming align well with the learning objectives of a computer science program.

Competing requires a high level of knowledge of efficient input/output techniques, libraries of different languages, data structures, efficient and optimized algorithms, and problem-solving and critical

thinking skills, which are fundamental to a computer science education, and will be explored in this course and much more.

Course Aims

This course aims to empower students with existing exposure to competitive programming, data structures, algorithms, and programming languages with a more comprehensive skill set by immersing students in the world of competitive programming. Students will have an opportunity to deepen their understanding of the fundamentals, data structures, and algorithms and enhance their problem-solving skills, collaboration with peers, and ability to come up with efficient and optimized solutions for problems under time constraints and participate in programming contests, thereby preparing them for real-world programming challenges.

In addition, it will also allow students a creative outlet for their studies in abstract computer science topics like data structures and algorithms, computational geometry, and geometric problems, graph theory, and network flow analysis. Through inclusive activities, it will indirectly serve to popularize competitive programming on campus and prepare teams for the International Collegiate Programming Contes (ICPC), which will in turn make our students more attractive to industry and graduate schools.

Course Learning Outcomes (CLOs)

CLO	Outcome / Description	Learning-Domain-Level
CLO 1: Problem Solving	Dissect complex algorithmic problems, employing systematic problem-solving techniques to devise efficient and optimized solutions	Cog-4
CLO 2: Algorithmic Proficiency	Deep understanding of algorithmic concepts, recognizing appropriate algorithms and data structures for various problem scenarios, and employing them effectively	Cog-2, Cog-3, Cog-5
CLO 3: Efficient Code Implementation	Translate algorithmic solutions into clean, concise, and efficient code	Cog-6
CLO 4: Time-Pressured Development	Devise creative solutions under time constraints such as in a competitive environment	Cog-5

CLO	Outcome / Description	Learning-Domain-Level
CLO 5: Collaboration	Fruitfully collaborate with their team on the creation and development of solutions to problems	Aff-3

Format and Procedures

This is a 300-level course of 3 credit hours, requiring a good grasp over at least two programming languages: C++ and Python are preferred, however, Java, Javascript, and any other popular programming languages are also acceptable. 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. Attention in lectures is imperative, and all assignments must be done in a timely manner.

We will use several online platforms:

- Canvas: Habib University's LMS and our course page, on it is your one-stop-shop for all official course information.
- Live Syllabus(if made): This is an up-to-date version of the course schedule as the semester proceeds.
- GitHub: *must add something over here if needed else remove please**
- Open Kattis: problem sets will be created and attempted over Kattis.
- Codeforces: mini-contests, mids, finals, and all such competitions will be taken over Codeforces.

Expectations:

So that you succeed in this course, we expect that you follow the good academic practices listed below:

- You will become familiar with the *online platforms* used in this course.
- You will *check your email regularly* and stay abreast of course communication.
- You will *read the book* and stay abreast of it as the course proceeds.
- You will be *fully present* in the class. That is, both physically and mentally. Please give your full attention to the class and participate actively.
- You will *take responsibility* for your learning:
    - *Seek help* when you need it.
    - *Be honest* about your work.

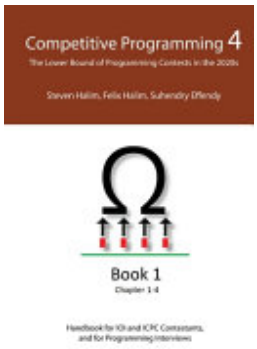
    - *Complete* the assignments and all relevant work in a timely manner.
    - Be a *good team player*. A good part of this course will be in teams. Ensure that teamwork is a good learning experience for everyone.
- Concerns regarding a score can be reported up to a week after its release. Concerns raised later cannot be entertained.
- You will maintain behavior in class that *befits* Yohsin and acknowledges the classroom as a place of learning, exploration, and experimentation.

Mode of Instruction

Instruction in higher education all over the world has vacillated unpredictably between in-person and online for more than two years, leading to at least one important lesson. We do not like remote, online learning or instruction. To every extent possible, this course will take place in person. We will meet twice a week for 75-minute lecture sessions.

In the unfortunate circumstance where we need to go online, relevant instructions will be shared accordingly. For that contingency, you should have a computer with an internet connection that is capable of running a latest browser version and Zoom.

Required Texts and Materials



Competitive Programming 4 - Book 1
ISBN: 9781716745522
Authors: Steven Halim, Felix Halim, Suhendry Effendy
Publication Date: 2018-12-03

Competitive Programming 4 - Book 2
ISBN: 9781716745515
Authors: Steven Halim, Felix Halim, Suhendry Effendy
Publication Date: 2020-07-18

Assessments

Assessment Type	(%)	Remarks
Problem Sets (best _)	30	These will be attempted individually on Open Kattis. Problem Sets will be released every week.
Problem Setting	10	By the course end, each student will have to individually submit an original problem made by them.
External Contest Participation	05	Each student will be rewarded points for participating in contests externally. This can be individual or in teams.
In-Class Contests	20	These will be done in teams of three at most over Codeforces, simulating a competitive programming environment.
Midterm Contest	15	The midterm will be a competitive programming contest done in teams of at most three.
Final Contest	20	The final will be a competitive programming contest done in teams of at most three.

To keep up with the lectures and to provide adequate practice, problem sets will be released every week containing problems on material covered in the same week. Students will have until the release of the next problem set to submit their solutions.

Grading Scale

Letter Grade	GPA 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)

Letter Grade	GPA Points	Percentage
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]

Note: [a, b) is a range of numbers from a to b where a is included in the range and b is not.

Late Submission Policy

Please observe the deadline prescribed for each assessment. There is no late submission policy. It is better to submit partial work on time and receive partial credit than to submit complete work late and receive no credit. In order to avoid last minute emergencies, e.g. power failure close to the deadline, start your work early and aim to finish it in advance of the deadline. With special approval from your instructor, you may submit late within the faculty's assigned deadline with a 20% late submission penalty. Please be mindful of deadlines and discuss with your instructor beforehand if you foresee any issues.

[*And any other information as per instructor's need]

Week-Wise Schedule (Tentative)

The schedule may change in view of class progress as the semester proceeds. All indicated chapters under Reading are from the course textbook. See the **Live Syllabus** for an updated version. [*Please upload live syllabus]

Week	Description / Topic	Readings	Assessments and Due Date
Week - 1	Introduction: Input/Output Techniques, Ad Hoc Simulation	Chap 1, 5.2, 6.2, and Chapter 9	Problem Set 1
Week - 2	Elementary Data Structures, Libraries in Python and C++	Chap 2 till 2.2, 8.7.2	Problem Set 2
Week - 3	Data Structures and Sub-linear complexity data structures	Chap 2 complete, 9.3	Problem Set 3
Week - 4	Searching and Sorting, Problem-Solving Paradigm: Divide and Conquer	Chap 3 till 3.3, 4.2.6, 8.2, 9.2	Problem Set 4

Week	Description / Topic	Readings	Assessments and Due Date
Week - 5	Greedy Algorithms	Chap 3 complete, 8 with focus on 8.3, 9	Problem Set 5
Week - 6	Dynamic Programming	Chap 3 complete, 8 with focus on 8.3, 9	Problem Set 6
Week - 7	Midterm Week - Midterm Contest	All readings yet	-
Week - 8	Graphs, Graph Traversal, and algorithms including BFS and DFS	Chap 4, focus on 4.2, 8.2.1, 8.2.2, 8.5, 8.7.4, 8.7.6	Problem Set 7
Week - 9	Intermediate Graph Algorithms and Trees	Chap 4, focus on 4.2, 4.3, 4.6 and 4.7, 8.2.2, 8.5, 8.6	Problem Set 8
Week - 10	Shortest Path Algorithms	Chap 4, focus on 4.4 and 4.5, 8.6	Problem Set 9
Week - 11	Network Flow Problems	Chap 8, focus on 8.4, 9.25	Problem Set 10
Week - 12	Computational Geometry and Geometry Algorithms	Chap 7, 8.7, 9.18, 9.19	Problem Set 11
Week - 13	Strings, matching, Suffix Tree, Prefix Tree, Tries	Chap 6	Problem Set 12
Week - 14	Mathematics and Number Theory	Chap 5, focus on 5.2 and 5.3, relevant problems from chap 9	Problem Set 13
Week - 15	Combinatorics	Chap 5, focus on remaining topics: 5.4 onwards, chap 9 problems	Problem Set 14
Week – 16			
Some dates	Reading Days	-	
Some dates	Final Examination Days[§]	All readings yet	

Attendance Policy

You are expected to attend and participate in all lectures and contests. Under extenuating circumstances, you may miss up to 04 synchronous sessions. In case of a missed session, you must inform your instructor of the reason. Failing to do so may raise an early academic alert with the Office of Academic Performance (OAP). Excessive absences will lead to an automatic withdrawal from the course.

Final Exam Policy

The Final Exam is going to be a 3-hour long programming contest in teams of at most 3 students. The contest is going to be held on Codeforces and will simulate a competitive programming environment, following all formats and practices of the International Collegiate Programming Contest (ICPC).

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.

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.

a. 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.
b. Cheating: The term cheating shall refer to the use of or obtaining of unauthorized information in order to obtain personal benefit or academic credit.
c. 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 lecture and the sections 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.

If you wish to use generative-AI tools to complete any of your assessments, you must first obtain permission from your course instructor. AI generated work will not be accepted in all classes or even all assessments. The instructor's permission is required. If the permission is granted, you should declare its use and properly cite the source of the generated content. Failing to identify AI written or assisted work is academic dishonesty and will be treated as any case of plagiarism by the university.

The principle for academic integrity is that your submissions must be substantially your own work and that any work that is not originally your thought must be identified and credited. If the use of AI tools is prohibited in the course, respect the rules and do not use these tools for assessments. The fundamental purpose of assessment is to learn, synthesize information and explain new connections and interpretations that arise from your secondary research. Be aware that unauthorized use of AI tools for assessments can result in a conduct case being filed. This can have serious consequences for your academic standing and future career opportunities.

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.

Program Learning Outcomes (For Administrative Review)

Upon graduation, students will have the following abilities:

- PLO 1: Analysis: Analyse a given situation and reduce it to one or more problems that can be solved via computer intervention.
- PLO 2: Design: Design one or more computer-based solutions of a given problem and select the solution that is best under the circumstances.
- PLO 3: Programming: Program a given solution in a variety of programming languages belonging to different paradigm.

- PLO 6: Self-learning: Research, learn, and apply requirements needed to implement a solution for a given high level problem description.

- PLO 8: Communication and Teamwork: Work effectively in inter-disciplinary teams.

Program Learning Outcomes (PLOs) mapped to Course Learning Outcomes (CLOs)					
	CLOs of the course are designed to cater following PLOs: PLO 1: Analysis PLO 2: Design PLO 3: Programming PLO 6: Self-Learning PLO 8: Communication and Teamwork				
	Distribution of CLO weightages for each PLO				
	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
PLO 1					
PLO 2					
PLO 3					
PLO 6					
PLO 8					

Mapping of Assessments to CLOs

Assignments	CLO #01	CLO #02	CLO #03	CLO #04	CLO #05
Problem Sets	X	X	X		
Problem Setting	X	X			
External Contest Participation	X	X	X	X	X
In-Class Contests	X	X	X	X	X
Midterm Contest	X	X	X	X	X
Final Contest	X	X	X	X	X

Recording Policy

Only asynchronous and synchronous online sessions will be recorded and uploaded on our Video Management System (Panopto). Link to the folder of recordings will be available to all students. Hyflex classes might be recorded if faculty deems it appropriate.

Accommodations for Students with Disabilities

In compliance with the Habib University policy and equal access laws, I am available to discuss appropriate academic accommodations that may be required for student with disabilities. 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. Students are encouraged to register with the Office of Academic Performance to verify their eligibility for appropriate accommodations.

Inclusivity Statement

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

Office Hours Policy

Every student enrolled in this course must meet individually with the course instructor during course office hours at least once during the semester. The first meeting should happen within the first five weeks of the semester but must occur before midterms. Any student who does not meet with the instructor may face a grade reduction or other penalties at the discretion of the instructor and will have an academic hold placed by the Registrar’s Office.