COMP 6651 Algorithm Design Techniques Fall 2024

Time: Tues/Thurs 11h45-13h00 (Lecture), Room H-937

Course Instructor: Thomas Fevens

Means of Contact: Email: thomas.fevens@concordia.ca

Office Hours: Thursdays 13h30-14h30, ER-947 (or by appointment; email me first)

Programmer on Duty (POD): Information on Moodle page when available.

Course Website: Please go to "Concordia.ca / Student Hub / My courses / My Moodle" and then click on "COMP-6651-2242-D" course link under "Fall 2024". The website will host ALL documents related to this course. We will use Moodle for most course activities. The scheduled **midterm** and **final exam** will be **in-person**. You MUST visit this web site regularly.

Lectures: Lectures for this course will be held in person in the assigned classroom during the scheduled time slot. The slides used during the lectures will be posted beforehand on the Moodle course page.

Course Calendar Description: (4 credits) Mathematical preliminaries; Empirical and theoretical measures of algorithm efficiencies; Optimization and combinatorial techniques and algorithms including greedy algorithms, dynamic programming, branch-and-bound techniques, and graph network algorithms; Amortized complexity analysis; String matching algorithms; NP-complete problems and approximate solutions; Probabilistic algorithms. A project is required.

Prerequisites/Co-requisites: N/A

Specific Knowledge and Skills Needed for this Course: This course requires a good understanding of concepts and techniques in discrete mathematics. We recommend, in particular, that you refresh your knowledge of the following topics: sets, functions, relations, graphs, and proof techniques. E.g., material covered in COMP 5361, COMP 5511.

Required Textbook: Introduction to Algorithms, fourth edition by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Hardcover ISBN: 978-0262046305. The text will be available at Campus Bookstore (online at concordiastores.ca), direct from the publisher The MIT Press as an eBook (see link on Moodle page), from VitalSource.com as an electronic book, from Amazon.ca in the Kindle format, and it is available from the Concordia Library. In addition to the text sections listed in the tentative schedule below, there could be some material (not covered in the text) presented in the course slides and in lectures.

Grading Scheme: Your final course grade is computed according to the following Scheme:

Grading Scheme	
Assignments (4)	16%
Midterm	19%
Project	20%
Comprehensive final exam	45%

The default grade is 0 for any missing course component, i.e., assignment, project, or test. According to departmental practice, there is no standard relationship between the numerical percentages and the final letter grades given, except that higher percentages map to equal or higher grades.

To pass the course, a student must obtain passing marks on **both** the term component (assignments and midterm) and the final exam.

No "additional work" will be accepted to make up for any of the above components.

Assignments: There are four assignments worth, in total, 16 percent of the final grade. Each assignment, which must be done individually, is worth 4%. Assignments are due according to the following schedule (weeks are listed on Moodle page).

Assignment	When Due
Assignment 1	Monday, Sep. 23
Assignment 2	Monday, Oct. 14
Assignment 3	Monday, Nov. 11
Assignment 4	Monday, Dec. 2

For this course, only electronic submissions will be accepted. You must upload these to the course website on Moodle. Hard copies will be neither accepted nor evaluated. In case of difficulty in electronic submission, please contact the instructor or marker.

Late submissions (up to 2 days, including holidays and weekend days) are accepted for Assignments 1 to 3, but will suffer a fixed penalty of 20%, unless you have a (really) good reason. Assignments more than two days late will get no credit. No late submissions will be accepted for Assignment 4.

Assignment Schedule: Assignments are to be "handed-in" by electronic submission in Moodle by **23h55 of the due date**. For each assignment, you should submit the answers in the form of a single PDF document (for other formats, check with the marker; do not compress/zip/tar your submission). You must typeset the text portion, including any mathematical formulations, of your solution using a document formatting software. **Scanned handwritten solutions will not be graded.** You may scan hand-drawn figures, and similar, of your solution into the document. Do NOT hand in hard copies of any part of your assignment. You are advised to retain a copy of all your term work (and proof of electronic submission) until you receive a final course grade.

Midterm: The confirmed dates for the midterm are listed below, along with the topics covered.

Material Covered	Dates
§3.1-3.3, 4.1-4.5, 4.7, 7.1-7.4, 8.1, 9.1-9.3, 14.1-14.5, 15.1-15.3, 16.1-16.4	Oct. 22 and 24

The midterm will be conducted in person (more details will be posted on Moodle). The midterm will be a two-stage exam, spread over two days. The first stage will be held on Tuesday, October 22, during the regular lecture period. This stage will be a timed exam, answered individually, that will be 1 hour long, starting at 11:50am. (NO ALTERNATIVE MIDTERMS WILL BE OFFERED.) The second stage will be held on Thursday, October 24, during the regular lecture period. This stage will be a group exam, answered in groups of at most four students, and will be 30 minutes long. You can choose not to participate in the second stage group exam. The midterm mark will be (marks out of 100):

maximum(stage 1 exam mark, 85% of stage 1 exam mark + 15% of stage 2 exam mark)

Both stages are closed book tests. Calculators authorized by ENCS are permitted.

Final Exam: The final exam will be scheduled by the GCS-ENCS Faculty. When known, the date will be posted on the Moodle webpage. The final exam will be conducted in-person (NOT ONLINE) during its scheduled day and time. This is a closed book exam. Calculators authorized by ENCS are permitted. The material covered is the **entire course material** including material covered on the midterm.

Project: There will be a project, done in groups of at most four. Further instructions will be posted on Moodle.

Learning Objectives/Outcomes: Learning objectives/outcomes include:

1. The learning objectives of this course are to:
   a. introduce students to the foundations of algorithmic thinking;
   b. develop abilities and skills of students to design and analyze algorithms for various computational problems, write pseudocode, and carry out rigorous arguments and proofs.
2. After successfully completing this course, students will be able to:
   a. design divide-and-conquer algorithms;
   b. design greedy algorithms;
   c. design dynamic programming algorithms;
   d. design linear programming algorithms;
   e. design approximation algorithms;
   f. design graph algorithms;
   g. analyze time complexity of algorithms;
   h. classify computational problems as belonging to classes P, NPC, etc.

Schedule: (*Additional material beyond textbook material may be present in course slides.)

Week	Topics Covered	Text Sections*	Assignments
Week 1 9/2-9/6	Introduction and Mathematical Preliminaries.	§3.1-3.3, 4.3-4.5, 4.7	#1 out
Week 2 9/9-9/13	Divide-and-Conquer. Quicksort	§4.1-4.2, 7.1-7.4, 8.1	
Week 3 9/16-9/20	Order Statistics	§9.1-9.3	
Week 4 9/23-9/27	Dynamic Programming	§14.1-14.5	#1 due (9/23) #2 out
Week 5 9/30-10/4	Greedy Algorithms. Amortized Analysis	§15.1-15.3, §16.1-16.4	
Week 6 10/7-10/11	Graph Algorithms: Elementary Algorithms, Minimum Spanning Trees; Disjoint Sets	§19.1, 20.1-20.5, 21.1-21.2	
10/14-10/18	Mid-term Break		#2 due (10/14)
Week 7 10/21-10/25	**Midterm exam, individual** (Tuesday) **Midterm exam, group** (Thursday)		#3 out
Week 8 10/28-11/1	Graph Algorithms: Shortest Paths, Maximum Flow	§22.1-22.5, 23.2, 24.1-24.3	
Week 9 11/4-11/9	Linear Programming. String Matching	§29.1-29.3, 32.1-32.2	
Week 10 11/11-11/15	NP-Completeness	§34.1-34.3	#3 due (11/11) #4 out
Week 11 11/18-11/22	NP-Completeness, cont.	§34.4-34.5	
Week 12 11/25-11/29	Approximation Algorithms	§35.1-35.3, 35.5	#4 due (12/02)

DISC Deadline: Last day for academic withdrawal is Monday, December 2, 2024.

Extraordinary Circumstances: In the event of exceptional circumstances and pursuant to the Academic Regulations, the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the

changes**.**

IP: Content belonging to instructors shared in courses, including, but not limited to, lectures and course notes remain the intellectual property of the faculty member. They may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of a lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Code of Conduct and/or the Code of Rights and Responsibilities. As specified in the Policy on Intellectual Property, the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

Health and Safety Guidelines: All health and safety rules specific to this course can be found in the lab manual. General health and safety instructions and available health and safety trainings can be found at: Safety Programs - Concordia University (https://www.concordia.ca/campus-life/safety/general-safety.html)

On Campus Resources: Please visit Student services at Concordia University for the services available Gina Cody School students. Located at: https://www.concordia.ca/ginacody/students/services.html

Plagiarism: The most common offense under the Academic Code of Conduct is plagiarism which the Code defines as **"the presentation of the work of another person as one's own or without proper acknowledgement."**

This could be material copied word for word from books, journals, internet sites, professor's course notes, etc. It could be material that is paraphrased but closely resembles the original source. It could be the work of a fellow student, for example, an answer on a quiz, data for a lab report, a paper or assignment completed by another student. It might be a paper purchased through one of the many available sources. Plagiarism does not refer to words alone - it can also refer to copying images, graphs, tables, and ideas. "Presentation" is not limited to written work. It also includes oral presentations, computer assignments and artistic works. Finally, if you translate the work of another person into French or English and do not cite the source, this is also plagiarism.

In Simple Words:

Do not copy, paraphrase or translate anything from anywhere without saying where you obtained it!

(Source: The Academic Integrity Website: http://concordia.ca/students/academic-integrity/)

Accessibility: Instructor will strive to make learning experience as accessible and inclusive as possible. If you have accessibility needs that require academic accommodations, please meet with an advisor from the Access Centre for Students with Disabilities (ACSD) as soon as possible to set up an accommodation plan. I welcome meeting with all students to discuss their accessibility needs. http://concordia.ca/students/accessibility/

Sexual Violence: Sexual violence, including sexual harassment and sexual assault, is not tolerated at Concordia. Please see Concordia's policy on sexual violence for more information about awareness and prevention, support for survivors/ victims, responding to disclosures and procedures for reports and complaints. You can also contact the Sexual Assault Resource Centre for information and support. More information and support are available at the Sexual Assault Resource Centre: http://concordia.ca/students/sexual-assault/, by email sarc@concordia.ca or phone 514 848-2424x3353