Course Motivation: Algorithms provide methods for solving problems, and are at the foundation of computing. It is important that practitioners in electrical and computer engineering understand how algorithms are designed, and how to analyze them for correctness and efficiency. It is important also to be able to distinguish intractable problems from ones that are tractable so one does not naively seek efficient solutions when none may exist. For cases that are intractable, it is important to know how to design approximate solutions that satisfy bounds on correctness and efficiency. Industry has long recognized the critical importance of algorithms that are correct and efficient.

Instructor: Prof. Mark Crowley   (mark.crowley@uwaterloo.ca; Office: E5 4114).

- Office Hours: TBD
- **[EMAIL]** Don't use it![1] post questions to Piazza for all course related communications. If you post as private then none of your classmates will see it, only the professor and the TAs.

Website: http://markcrowley.ca/algorithms
Course Content (on Learn): http://learn.uwaterloo.ca/
Piazza: TBD

TAs:

- TBD

Lectures:

- **Section 1:** Mondays and Fridays: 1:00pm - 2:20pm (E7 5353)
- **Section 2:** Mondays and Fridays[2]: 4:00am - 5:20pm (E7 5353)

- The lectures will be held in person. Students will be required to follow the University policy on masks (Masks are required as of this writing, but check https://uwaterloo.ca/coronavirus/ for the latest policy.)
- Lectures will not be held during reading week (Feb 20 - 24).

Tutorials:

- **Section 1:** Thursdays: 7:00pm - 7:50pm (E7 5353)
- **Section 2:** Tuesdays: 7:00pm - 7:50pm (E7 5353)

The tutorial will be held in person. Students will be required to follow the University policy on masks (Masks are required as of this writing, but check https://uwaterloo.ca/coronavirus/ for the latest policy.)
Course Objectives: At the end of the course, it is hoped that you can:

- write pseudocode for algorithms
- analyze the run-time and correctness of an algorithm
- design efficient algorithms using divide and conquer, greedy algorithms, and dynamic programming

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[1]Alright, you *can* use email in some cases. Particularly, for issues with the course staff including the professor or TAs. But if you email me, then **be sure** to put "ECE406" at the front of your subject line.
[2]yes, I *know...*

- explain the kinds of problems that can be solved with linear programming, and why they can be solved efficiently
- explain the different complexity classes P and NP, and what it means for a problem to be "hard"
- explain what it means to reduce one problem to another, and demonstrate how to use for complexity analysis
- explain and use various methods for approximately solving hard problems

Course Outline: The focus of the course is the design and analysis of efficient, correct algorithms. Topics that will be covered include Advanced data structures, divide and conquer algorithms, recurrences, greedy algorithms, dynamic programming, graph algorithms, search and backtrack, inherently hard and unsolvable problems, approximation and randomized algorithms, and amortized analysis.

The following table provides more detail on the material covered in the class. Note that not all sections of each chapter will be covered.

Topic	Chapter in Text	Duration
Introduction to algorithms	Chapter 0	0.5 hours
Factoring, primality, cryptography	Chapter 1	4.5 hours
Divide and conquer algorithms	Chapter 2	5 hours
Graphs, decompositions and depth-first search	Chapter 3	3 hours
Paths in graphs: Dijkstra's alg, priority queues	Chapter 4	3 hours
Greedy algorithms: MST, MP3 encoding, set cover	Chapter 5	3 hours
Dynamic Programming: Shortest paths, knapsack	Chapter 6	4 hours
Linear Programming: Network flow, simplex algorithm	Chapter 7	4 hours
Inherently hard problems: NP-completeness, reductions	Chapter 8	5 hours
Intelligent exhaustive search and approximation algorithms	Chapter 9	4 hours

Textbook: The main (and required) text for the course is

1. S. Dasgupta, C. Papadimitriou, and U. Vazirani, *Algorithms*, McGraw-Hill, 2008.

The following textbooks may also be useful for additional information on subjects:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, MIT Press, 2009

2. J. Kleinberg and E. Tardos, *Algorithm Design*, Addison Wesley, 2005.

Grading: The course will consist of assignments, a midterm, and a final exam. There will be a total of six homework assignments, given roughly once every two weeks. The grading scheme is

- Assignments: 20%
- Midterm: 30%
- Final Exam: 50%

We will be using Crowdmark for grading. The midterm and final exam will be held in-person and will be closed book. Please see the COVID-19 contingencies below should in-person assessments not be possible.

Midterm Exam: TBD, TBD, location E7-5353, E7-4043, and E7-4053
(Please see COVID-19 contingencies below should in-person assessments be cancelled).

Assignments Information and Guidlines: Assignments are given every other week, and their primary goal is to give you practice in designing and analyzing algorithms. Be sure to spend a good amount of time working on these. Assignments are graded fairly leniently. Try not to worry about grades too much and just focus on getting practice. The following are some details:

- **There will be no extensions or late assignments accepted**. As compensation for this rather harsh rule, I will drop your assignment with lowest score when calculating the assignment average. To be fair to all students, requests for extension receive the following "canned" response:

  > The course policy is that there are no extensions for assignments. As compensation, I will automatically drop your lowest assignment grade of the six.

- Assignments are submitted using Crowdmark https://app.crowdmark.com/sign-in/waterloo.

- Programming exercises are written in **Python 3**, and your code is to be submitted in the corresponding dropbox on LEARN.

- Assignment are to be submitted individually and must be written in your own words. You are free to collaborate with other students on assignments in order to hash out initial solution ideas. You must list these collaborators at the top of the first page of your assignment (there is no penalty for listing collaborators, but it ensures we do not falsely identify plagiarism).

- Cite all sources used in your solutions (other than the course notes or the main textbook). In submitting an assignment, you are "signing off on your work" as described in the academic integrity form at https://uwaterloo.ca/academic-integrity/. The penalty for a first plagiarism offence is -100% for the assignment.

Instructional Contingencies for Covid-19:
Should we be required to move away from full-occupancy in-person teaching, the instructors will work with the Department to ensure that students have a fair opportunity to meet course requirements and to be notified of any changes in a timely manner. The course content will remain the same, but the following are preliminary plans on how lectures, midterm, and final exam will be modified if necessary:

Lectures: During a cancellation, lectures will be pre-recorded with links to lecture content posted on LEARN each week using the same style as the lectures for the first three weeks.

Assignments: There will be no change in assignments and they will continue to be submitted on crowdmark and LEARN.

Midterm: If in-person assessments are cancelled prior to the midterm, then this portion of the assessment will be replaced with TWO timed tests, held on crowdmark (see details of the online test format below). The 30% midterm grade will be computed as an average of these two tests.

Missing online tests: Should a test be missed for a valid reason (as determined by the instructor following university guidance), then the 2nd test will by given a weight of 15% and the final exam a weight of 65%. If you miss both tests, both for valid reasons, then the midterm will be given a weight of 15%, the final exam mark will be given a weight of 65%, and you will receive an INC until a makeup test (which will be the source of the test mark) can be arranged.

Final Exam: Should the in-person final exams be cancelled, the final exam will be held as a timed assessment on crowdmark, and will still be worth 50% of your total grade.

Details for online tests and exams:

- Any online tests/exams will be held as a synchronous timed assessment on crowdmark. The assessment will be released to all students at the same time and must be submitted prior to the deadline. The test time will include a sufficient amount of time to scan and upload your answers to each question. There will be a late penalty of 1% per minute for any submissions after the deadline.
- Online assessments will be open book in the sense that you may consult your course notes and material posted in the course LEARN site and lecture videos. Use of any other resource (including file-sharing services such as chegg.com, coursehero.com, stack-exchange.com, …) is prohibited. You may not communicate directly or indirectly with any person except the course instructor. You may not use any other computing tool (MATLAB, Python, etc.), unless it has been explicitly allowed.

General University of Waterloo Guidelines:

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check http://www.uwaterloo.ca/academicintegrity/ for more information.

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm.

When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity—check http://www.uwaterloo.ca/academicintegrity/ to avoid committing an academic offence, and to take responsibility for their actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about rules for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm.

For typical penalties check Guidelines for the Assessment of Penalties, http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

Appeals: A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for Students with Disabilities: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin) may be used to screen assignments in this course. Turnitin is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.