Course Syllabus Spring 2019

EECS 340/454: (Analysis of) Algorithms

Instructor: Mehmet Koyutürk

1 Course Objectives

"*Computer Science is no more about computers than astronomy is about telescopes.*"

– E. W. Dijkstra

This course provides an introduction to the design and analysis of algorithms for solving computational problems. It is expected that, upon completion of this course, the students will achieve the following tasks:

- Develop a comprehensive understanding of major algorithmic techniques and state-of-the-art algorithms for common problems.
- Become fluent in analyzing algorithms in terms of correctness and required computational resources.
- Become comfortable with formalism and doing proofs.
- Develop a vision towards using computational thinking effectively to solve challenging problems in a broad range of practical applications.
- Have fun! (make no mistake though, this is an important and rather challenging course that has to be taken seriously)

2 Class Meeting

Monday Wednesday 12:45 - 14:00, Clapp 108.

3 Course Personnel

Instructor: Mehmet Koyutürk, `mxk331@case.edu`
Office: Olin 512, *Office Hours:* Monday Thursday 2-3 PM

Teaching Assistants: Serhan Yilmaz, `sxy600@case.edu`
Office: Olin 513, *Office Hours:* Tuesday 2:30-4 PM

Yidi Huang, `yxh597@case.edu`
Office: Olin 513, *Office Hour:* TBA

Gary Yao, `gxy76@case.edu`
Office: Olin 513, *Office Hour:* TBA

4 Canvas Site

- EECS-340: `https://canvas.case.edu/courses/16455`
- EECS-454: `https://canvas.case.edu/courses/16456`

The Discussion boards on both Canvas sites will be populated with topics that relate to course material (Quiz 1, Quiz 2, ... Assignment 1, Assignment 2... etc.) If you have any questions, please post them on the appropriate board on Canvas rather than e-mailing to the instructor. The instructor and TAs will periodically check these boards and answer questions, and students are encouraged to answer each others' questions. This will minimize everybody's effort while allowing everybody benefit from the questions and discussions. You are allowed to discuss the solutions to the assignment problems on Canvas as well.

5 Textbook

T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. *Introduction to Algorithms*, 3rd Ed. Cambridge, MA: MIT Press, 2009. [ISBN: 978-0-262-03384-8.]

6 Prerequisites

A "C" in EECS 223 and EECS 302 for EECS 340, graduate standing for EECS 454. The prerequisite is strictly enforced. A very good understanding of discrete mathematics and data structures is essential for productive learning in this course.

7 Course Work & Grading

Participation: The students are expected to review the material to be covered before each class meeting, attend the class meetings, and actively participate in class discussions. It is imperative that students ask questions whenever something is not clear to them in the class. Active participation in class discussions will be used to the student's advantage while grading borderline cases. Use of laptops and tablet computers in class meetings is allowed as long as this does not cause any disturbance in the classroom atmosphere. **The use of mobile phones is not permitted**.

Assignments: (20%) There are 8 assignments for EECS 454, 7 assignments for EECS 340. The first 7 assignments is common, the last assignment for EECS 454 is on NP-completeness, which will not be covered in class. Each assignment consists of a few problems related to the material that was covered in class after the last assignment. The students will have two weeks to return the assignments.

The assignments will be graded on the basis of effort and understanding of material. The students are *allowed* (but **not required**) to work on assignments in teams of two and submit a joint assignment. (students in 340 and 454 are allowed to partner together) If two students submit a joint assignment, their assignment will be graded and both students will receive the same grade with no reduction. However, the number of assignments that can be submitted with the same partner is **limited to 3**. A student can submit all assignments with a partner, provided that no more than 3 assignments are submitted with each partner. While the students are allowed to talk about assignments and receive help from each other and course personnel as needed, each submitted assignment must uniquely represent the genuine work of submitting individuals. **Copying answers from other students/teams or from material on the web will not be tolerated.**

The students will electronically submit **pdf files**. (Assignments **written in LaTeX will receive 5 bonus points**). The students are responsible for the legibility of their answers. **If you use plain text or a word processor that is not suitable for writing equations leading to illegible answers, your submission will not be graded.**

Quizzes: (24%) There are six 10-minute in-class quizzes. Each quiz will contain a single question assessing the student's understanding of how to analyze algorithms using mathematical formalism (e.g., definition, proof etc.). Each quiz will be graded on a discrete 5-point scale: The proof/definition is solid and complete (4), the proof/definition is satisfactory, but has a minor flaw (3), the proof/definition is satisfactory, but has a major flaw (2), the proof/definition is not satisfactory (1), the student is absent (0).

Midterm Exam: (20%) There is one 75-minute midterm exam. The exam will consist of questions that aim to assess the student's understanding and ability to use and manipulate the methods and algorithms covered in class. It will not include any "formal proof" questions.

Final Exam: (36%) The final exam will be a 120-minute exam for EECS 340 and a 160-minute exam for EECS 454, covering all of the course material comprehensively. It will include easy-answer questions, as well as algorithm design questions. It will not include any "formal proof" questions. However, the additional question(s) for EECS 454 will be on NP-completeness, which will be a formal proof question.

The students are allowed to use the textbook (but no other printed material or electronic devices) in all quizzes and exams.

8 Calendar

- **Chapter 1: The Role of Algorithms in Computing**
  - Week 1: Overview of the course and conceptual introduction to Algorithms.
- **Chapter 2: Getting Started**
  - Week 1: Insertion sort (2.1)[1].
  - Week 1,2: Loop invariants (2.2), designing algorithms, merge sort (2.3).
- **Chapter 3: Growth of Functions**
  - Week 2: Asymptotic notation (3.1).
- **Chapter 4: Divide-and-Conquer**
  - Week 3: Strassen's algorithm for matrix multiplication (4.2), Recursion tree method (4.4).
  - Week 4: Master method (4.5), Substitution method (4.3).
- **Chapter 7: Quicksort**
  - Week 5: Description (7.1), worst-case performance (7.2),

[1]The numbers in parentheses refer to Section numbers in the textbook.

  - Week 5-6: Randomized quicksort (7.3), basics of probability (6.1, 6.2, 6.3), average-case analysis of quicksort (7.4).

- **Chapter 8: Sorting in Linear Time**
  - Week 7: Complexity of comparison-based sorting (8.1), Counting sort (8.2), Radix sort (8.3?), bucket sort (8.4?).
  - *Midterm Exam will be given some time around here.*

- **Chapter 15: Dynamic Programming**
  - Week 8: Rod cutting (15.1), Elements of dynamic programming (15.3),
  - Week 9: Subset-sum (notes will be provided by the instructor), Optimal binary search trees (15.5?).
  - Week 10: Longest common subsequence (15.4).

- **Chapter 16/23: Greedy Algorithms**
  - Week 10: Activity selection (16.1), elements of greedy strategy (16.2), examples.
  - Week 11: Minimum spanning trees (23.1, 23.2?., 23.3)

- **Chapter 22: Elementary Graph Algorithms**
  - Week 12: Representation of graphs (22.1), Depth-First Search (22.3).
  - Week 13: Topological sort (22.4), strongly connected components (22.5).

- **Chapter 23/24: Shortest Paths**
  - Week 14: Dijkstra's Algorihm (24.3), DAG-Shortest-Paths (24.2), Floyd-Warshall Algorithm (25.2?).

- **Additonal Material for EECS 454**
  - Notes on NP-Completeness from Kleinberg and Tardos' Algorithms textbook will be posted on Canvas. This topic will not be covered in class (unless there is extra time), but 454 students will be given an additional assignment and additional questions on this topic in the final exam.

9 Plagiarism Policy

Zero-tolerance policy on plagiarism is enforced. Following the university's plagiarism policy, cheating on homeworks or tests will result in an F grade for the whole course and appropriate disciplinary action, independently of the extent of plagiarism. In case of doubt, the students are responsible for checking with the TA or the instructor on what is allowed and what is not.