

Course Summary and Syllabus

*Lecturer: Chris Umans**Date: March 27***Course summary:**

Complexity Theory attempts to answer the question: What is computationally feasible given limited computational resources? In this course we will lay out a surprisingly rich landscape of complexity classes that are used to classify problems according to the resources (such as time, space, randomness, or parallelism) required for their solution.

We will build a detailed picture of how these classes are believed to fit together, and we will prove that some pieces of this picture are indeed correct. The question of whether the remainder of this picture is correct encompasses some of the deepest and most fundamental open problems in computer science, including $P \stackrel{?}{=} NP$ and many others.

Course Information:

- Instructor: Chris Umans (umans@cs.caltech.edu)
- TAs:
 - Dave Buchfuhrer (dave@cs.caltech.edu)
 - Domenic Denicola (domenic@domenicdenicola.com)
 - Cheng William Hong (cwhong@caltech.edu)
- Lectures: Tuesdays and Thursdays 1:00 – 2:25 in Jorgensen 74
- Office hours: TBD
- Webpage: <http://www.cs.caltech.edu/~umans/cs151/>

Prerequisite: CS 21 and CS 38 or permission of the instructor.

Text: *Computational Complexity* by Christos H. Papadimitriou. Addison-Wesley. 1995. This text should be on reserve at the library, and available at the bookstore. It is suggested that you have access to a copy, but not required.

Problem sets: The problem sets are extremely important – for this material, the best way to learn is by doing. I strongly encourage you to work in groups of two or three on the homework. However, you must each turn in your own write-up (preferably LaTeXed) and note with whom you worked. The rules on problem sets are:

- There are 7 problem sets. They are handed out at the end of the Thursday lecture, and they are due at the beginning of the following Thursday lecture.
- You may consult *only* the course notes (the posted lectures, and any notes you or others took during class) and the text (Papadimitriou).

- The quality (clarity, conciseness, neatness) of your write-up counts. I will provide a \LaTeX template as well as \LaTeX source for the problem sets to encourage you to prepare your solutions using \LaTeX .
- You may elect to take a two-day extension (until 5pm Monday) on *one* problem set without penalty. Other problem sets turned in late, but before 5pm Monday, receive half credit. Late problem sets should be turned in by putting them into my mailbox on the 2nd floor of Jorgensen.

Exams: There will be a midterm and final exam. They will be indistinguishable from the problem sets, except that they will be cumulative, and you may not work with others on the exams. The problem-set rules apply to exams as well. There are no extensions for the exams, and no partial credit for exams that are turned in late.

Feedback: If you have any comments or concerns on issues like: the pace of the lectures, the difficulty of the material, time spent on problem sets, or anything else, please let me or the TAs know!

Evaluation and Grades: Your grade will be based on the following (weighted) components:

Homework 60%; Participation 10%; Midterm 15%; Final 15%.

If you earn 90% of the available (weighted) points you are guaranteed at least an A of some form, 80% guarantees at least a B of some form, 70% guarantees at least a C of some form, etc... If you are taking the course pass/fail, you need to earn a C- or higher to pass.

Tentative schedule of topics:

Lecture	Date	Topic	Assignments
1	March 31	intro and review	
2	April 2	time and space classes	Problem Set 1
3	April 7	nondeterminism	
4	April 9	nondeterminism	Problem Set 2
5	April 14	nonuniformity and circuit complexity	
6	April 16	nonuniformity and circuit complexity	Problem Set 3
7	April 21	randomness	
8	April 23	randomness	Problem Set 4
9	April 28	randomness	
10	April 30	randomness	Midterm
11	May 5	alternation and the PH	
12	May 7	alternation and the PH	Problem Set 5
13	May 12	interaction	
14	May 14	interaction	Problem Set 6
15	May 19	PCPs and hardness of approximation	
16	May 21	PCPs and hardness of approximation	Problem Set 7
17	May 26	counting classes	
18	May 28	relativization and natural proofs	Final Exam
-	June 2		
-	June 4		Final Exam due