CS 151 Complexity Theory **Spring 2004**

Course Summary and Syllabus

Lecturer: Chris Umans *Date: March 30*

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 $\mathrm{P} \stackrel{?}{=} \mathrm{NP}$ and many others.

Tentative schedule of topics:

Lecture	Date	Topic	Assignments
1	March 30	intro and review	
2	April 1	time and space classes	Problem Set 1
3	April 6	nondeterminism	
4	April 8	nondeterminism	Problem Set 2
5	April 13	nonuniformity and circuit complexity	
6	April 15	nonuniformity and circuit complexity	Problem Set 3
7	April 20	randomness	
8	April 22	randomness	Problem Set 4
9	April 27	randomness	
10	April 29	randomness	Midterm
11	May 4	alternation and the PH	
12	May 6	alternation and the PH	Problem Set 5
13	May 11	interaction	
14	May 13	interaction	Problem Set 6
15	May 18	PCPs and hardness of approximation	
16	May 20	PCPs and hardness of approximation	Problem Set 7
17	May 25	counting classes	
18	May 27	relativization and natural proofs	Final Exam
-	June 1		
-	June 3		Final Exam due

Time and place: Jorgensen 287, Tu/Th 10:30-12:00 **Office hours:** TBD

Prerequisite: CS 138ab 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.

Webpage: `http://www.cs.caltech.edu/~umans/cs151-sp04/`

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

The rules on problem sets are:

- Problem sets 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 and the text (Papadimitriou).
- The quality (clarity, conciseness, neatness) of your write-up counts.
- You may elect to take an extension until 5pm Monday on *one* problem set without penalty. Other problem sets turned in late, but before 5pm Monday, receive half credit.

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.

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...