This course deals with some of the most fundamental philosophical questions surrounding computing. Is there such a thing as a “generic” computer? How powerful are computers? Are there fundamental limitations on what computers can do? It turns out that these questions are also very important to fundamental philosophical questions about mathematics. For instance, are there statements that are true but cannot be proven? What is the nature of infinity? In this course, we will embark on a systematic mathematical study of computation and try to get some answers to these and other questions.

The Winter offering of CS 181 is the advanced mathematical version of this class. In this class, we will derive theorems about the power and limits of computation. In many math classes, theorems and their proofs are revealed to students in an almost mystical way, as if only some distant alien genius could have come up with them. This is false: the theorems and proofs that we learn were discovered by people like you. In this class, we will try to demystify this process, and try to figure out what theorems to prove, and how to prove them, together in an interactive way. (This goal will not always be achievable due to time constraints, but this is the ideal we will shoot for.) The primary goal of this class is to enable you to learn how to think in this manner yourselves.

Many students find this class to be the most challenging course that they take at UCLA. (Student review excerpt: “[Sahai] expects more from us than any other professor.”) I want all of you to succeed. In order for that to happen, I need a commitment from you to work harder than you would normally expect to work. I believe every student who is willing to work hard can succeed in this course. All of you have what it takes. However, if you feel that you are overwhelmed, please talk to the TA or me as soon as possible. Do not delay. We want to help, but you need to let us know about your situation.

CS 180 is a critical pre-requisite for this class. (Math 115A is an alternative.) While CS 180 focused on efficiency, this class focuses on feasibility and infeasibility – understanding what problems can and cannot be solved by computers. However, even though the focuses of the two classes are very different, the understanding of mathematical proofs and proof techniques that you gained in CS 180 will be critical to your success in this class.

In this class, you will be required to write mathematical proofs. I urge you to review the following website to re-familiarize yourselves with proofs: [http://zimmer.csufresno.edu/~larryc/proofs/proofs.html](http://zimmer.csufresno.edu/~larryc/proofs/proofs.html)

General Information:

Textbook (Required): Michael Sipser. Introduction to the Theory of Computation, any edition. (I think that the price of a new 3rd edition text is insane. Feel free to buy used copies of older editions.) This textbook is excellent and very readable. Your ongoing assignment is to read along in the book, at your own pace, to reinforce what we cover in class.

Lectures: Kinsey 1200B, MW 4:10 – 5:50PM

(Note: As a convention to allow students to reach class without interrupting lecture, and as a courtesy to students coming from far away, we start each non-exam lecture at 4:10 PM. Please arrive by 4:10.)

Discussion Sections: F2-4 PubAff 2232, F4-6 MS 512B, F4-6 Geo 3656
Instructor: Professor Amit Sahai
Office: 497A Eng 6, Email: sahai@cs.ucla.edu
Office hours for 30 minutes immediately following each lecture (MW6-6:30)
TAs: Alexis Korb (Head TA), Aayush Jain, and Nathan Manohar

Online Discussion Forum: We will be using the online discussion website called Piazza. The TAs will provide further instructions.

Grading: Grading will be on a curve. The curve will be based on points earned before counting any extra credit. (So your extra credit cannot push down anyone else’s grades.) I anticipate that there will be 0-5% A+’s, 20-35% A’s, 20-35% B’s, 20-30% C’s, and 5-15% D’s & F’s. Note that these numbers may change because of students who drop the class, likely increasing the proportions of higher grades.

There will be a total of 400 points possible for students to earn, partitioned as follows:
- Problem Sets (between 5-7 total, 15-20 hours each): **100 points**
- In-class Midterm Exam (currently scheduled for Feb 13): **125 points**
- Take-home Final Exam, due Mar 15: **175 points**

Your grade will also be multiplied by an Ethics Score between 0 and 1, determined by how well you follow the honor code.

In addition, I will be employing an experimental token system to increase classroom participation and to encourage you to think actively about the material during class. This will work as follows:

- During lecture, I will often ask questions related to class material. Every time you answer a question with a clearly expressed good idea, you'll receive a token that is worth 1 extra credit point (out of the 400 total normally possible for the course).

  - If you received a token during lecture, then at the end of each lecture, please write your (1) Name, (2) UID, and (3) the number of tokens you received and turn it in to the TA along with the tokens.
  
  - Please feel free to read ahead in the (excellent) textbook to prepare for lectures, and if you know the answers to my questions (or have a good idea), please do raise your hand and speak clearly and thoughtfully when I call you. I will ask several questions in each lecture, and so these tokens can add up and make a substantial difference in your final grade.
  
  - If you feel that I have neglected to call on you, please talk to me at the beginning of the next lecture, and I will try to look out for you.
  
  - Also, if I called on you, and you didn’t get a token despite an indication from me that I found your answer to be insightful, please don’t hesitate to see me after class. I often get so caught up in an exciting idea that I forget to hand out a token.
  
  - Nevertheless, my decisions on who to call on and which answers merit a token are final and not subject to negotiation or appeal.
  
  - Also: on the Piazza system, we will choose the best answers given by students on Piazza to student questions for recognition – just like a token, this will be worth 1 extra credit point.

Schedule: As you will see, this course is very interactive. As a result, there is no pre-set schedule for lectures or readings, and this changes considerably from year to year. If you must miss a lecture, please be sure to find out what was covered from a friend in the class.