CSC 286/486: Computational Complexity
Course Information Handout/Syllabus
Version 1.2 (any substantially updated versions of this document will be announced as the course goes on via BB and made available on the course home page)
Fall 2015 Semester
2015/8/31 (last updated: 2015/9/8/1042am)

Location/Time: The course meets in Room CSB 632, M/W 2:00PM–3:15PM.

Instructor: Lane A. Hemaspaandra, CSB 618, cs486 “at” cs.rochester.edu. Office hours: Wednesdays 3:15PM–4:15PM in CSB 632 and/or CSB 618 (but please always feel free to stop by any time without an appointment or, easiest of all, grab me right before or after one of our class sessions).

TA: Mohammad Hedayati, CSB 615, cs486 “at” cs.rochester.edu. Office hours: Mondays/Wednesdays 3:15PM–3:55PM and Tuesdays 4:50PM–5:30PM, all in CSB 615 (except on Mondays and Wednesdays he may be in CSB 632 for some bit of time before moving to CSB 615). (Also, please always feel free to stop by his office any time without an appointment, and if he has time he’ll see you then, or otherwise will try to make a separate later appointment with you.) And on Thursdays (except not after classes end or during Thanksgiving recess), starting September 3th, Mohammad will conduct a weekly, optional Review Session at 4:50PM (lasting 50–100 minutes, most typically ending in around 75 minutes) in room (probably) CSB 632. Students typically find these review sessions to be very valuable in staying on top of this course’s (quite demanding) material.

Address for Course-Related Email: Please use cs486 “at” cs.rochester.edu. (This address will be automatically forked by the system to go to both me and the TA. Please make sure to always use it so that neither of us is left out of the process of being on top of any questions and discussion. The only exception is if you are for example trying to set up a one-on-one appointment time with Mohammad, then you might want to write him directly at his just-him email address of hedayati “at” cs.rochester.edu.)

Overview: This course studies between computable and uncomputable problems and between feasible and infeasible problems. Regarding the latter, what properties of a problem make it computationally simple? What properties of a problem may preclude its having efficient algorithms? How computationally hard are problems? Complete sets and low information content; P=NP?; unambiguous computation and one-way functions; reductions relating the complexity of problems; complexity classes and hierarchies.

Prerequisites: CSC 280 (prereq). You should also have taken (or know equivalently well) discrete mathematics (MTH 150), which is a prerequisite of CSC 280.
Homework Preparation/Class Participation: You may discuss and work with other CSC286/486 students on the reading, studying, and problems; the goal of the course is not to compete with each other, and, indeed, in real research, collaborative work is very common. However, it is cheating to solicit help from anyone other than your classmates—this includes using electronic forums such as wikis/newsgroups (or even mailing lists that function as electronic discussion forums) and also includes using solution sets from previous years’ CSC286/486. Also, your write-up of your homework answers (on graded homework assignments) must be your own work/words, even if you discussed the problems with others; you may in no case copy all or part of anyone else’s write-up. (A very wise way to achieve this is as follows: Even if you have discussed the problem with others, as you do your final write-up have nothing in front of you but rather write just from the knowledge/images of the solution you have in your head.) Homeworks must be submitted on time; late homeworks get no credit (and will not be graded or marked up with comments; although you always can stop by the TA’s or my office hours to, after solutions have been gone over in class, make sure you understand those solutions or to discuss an alternate approach). (No late homeworks means no late homeworks; even if one of my faculty colleagues—even if he or she is the chair—tells you that he or she thinks it will be ok to hand in late a homework assignment in this course, even for some very good reason such as there being a research paper deadline or there being a fellowship deadline, you nonetheless must hand in your homework on time in this course if you wish to get credit for it; similarly, none of my faculty colleagues can excuse you from this course’s quizzes, homeworks or exams.) Also, you must write yourself your one-sheet notes allowed on quizzes and tests (see below). Note that the quizzes make it counterproductive to ever be in the state of having relied so heavily on classmates that you do not yourself fully understand everything. The TA and I generally won’t answer questions about homework questions that are currently in progress (my typical answer to such questions is to point to this sentence (let us label this sentence “β54391” as a convenient reference string), or “no comment,” or “understanding the question is part of solving the question” or if it was asked by email simply not to reply); of course, if you have questions about the underlying material (that a question might be related to), you can and should use the office hours or the review sessions to ask questions about or better learn about that material (but not to ask for answers to or explanations of in-progress homework questions).

You may bring to each class one sheet of handwritten notes (writing on both sides is allowed; you may alternatively bring two sheets on which each has one side with handwritten notes and one side that is totally blank), prepared yourself. You may use this sheet of notes on a surprise quiz that class. (Separate from this is the issue of bringing in notes on the homework problems. If you are called on to present some of the homework problems, you may bring with you to the blackboard as many sheets as you like of your own handwritten notes on the problems.)

Regarding class participation, even though it does not directly contribute points to the score calculation, you are expected and required (and this will be kept in mind when assigning your course grade): to attend class, to be prepared for class, and to participate
in class. For example, if you are called on to put up your answer to a for-home-thought problem and it is clear you have not put in a substantial amount of time and thought, that could lower your grade. Note that, even if you do not know a perfect answer, if you clearly have put in careful thought (e.g., you have partial results or a clear description of what issue is stumping you), that certainly will make a much better impression on me than if you clearly have not thought at all about it. As another example, if you have not done the assigned reading, that could lower your grade.

By the way, if you have a question in class about some of the course material, it usually is a good idea to ask it. Probably other students have exactly the same question,¹ and you will be doing yourself, them, and the class a big favor by asking, so we all can explore whatever issue you raise!

(Some caveats: This is a course on certain material, not a course on how to design and teach a course on that same material. Thus please do not ask course-design/course-logistics questions such as “Why is there so much homework?” or “Why can’t I use my computer, my full notes, my supersmart pet dog Fido, and our textbooks during quizzes?,” and I typically won’t answer such questions—most especially not during class time. Also, audio or video recording of the class sessions is not permitted, except if you have a documented disability that would need such recording, in which case please speak to me about this. More generally, no laptops or smartphones should be opened or in use in class—except any laptop that is connected to the projector to give the day’s talk—nor may you Skype in—not even in silent view-only mode—on days you can’t attend class, nor may you have a classmate electronically record or transmit that class session for/to you. If you cannot attend, though, of course do get from a classmate (in the dream case, one you have warned to please take notes for you due to you having to miss the class session) a detailed account of what happened in class and if some of our course slides were covered in class that day you’ll want to find out from your classmate which were, and read them, and also missing a class when something was handed back does not change your regrading window, so do pick up from the TA your handbacks at his next office hour or if that is beyond the regrading window or is too close to its end, try to arrange with him to get it back even earlier (perhaps you can ask him—ahead of the class you’ll miss—to give it at that class session, in a sealed envelope, to a friend in class to bring to you), as needed.)

**Grading:** The overall course grades (A, A-, etc.) will not be any fixed curve, but rather will reflect the instructor’s judgment about what grade is appropriate based on performance. Each of the two midterms counts for 18% of your course average. Your quiz average counts for 25% of your course average. Your homework average counts for 39% of your course average. Note that the stress here is not on learning things the day before an exam and forgetting them the day after, but rather is on having/gaining/sustaining day-after-day

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¹Even professors sometimes—more often than they would like to admit—don’t understand talks/lectures, even in their own areas! Here is a cute, relevant anecdote from Moshe Vardi’s introduction to the September 2011 issue of *CACM*, where he mentions asking, at a top theoretical computer science conference, how many people understood at least N% of at least N% of the papers—to get 50% of the people to say yes, he had to drop N down to 50. Understanding lectures is a nontrivial challenge, and requires a lot of focus!
and week-after-week performance, competence, and with luck mastery, as reflected in your quizzess and your homeworks. It is a 14-week course, not a 150-minute course.

If you are taking the course as 486, in computing your quiz average we will drop the 2 lowest quizzes; in computing your homework average we will drop the lowest homework. If you are taking the course as 286, in computing your quiz average we will drop the 4 lowest quizzes; in computing your homework average we will drop your two lowest homeworks.

As to grades (and what is made public and what is not), each student gets his or her own grade on each quiz, homework, and midterm (and of course I assume and expect that you will keep each given-back item/grade), and through Blackboard he or she will see some information about the overall class performance each of those items, and at the end of the course he or she will receive his or her course grade either from the registrar or from me. However, I in general do not give out grade or grade-distribution or grade-range-cutoffs info beyond that (or provide guesses of what letter grade a student is “headed toward”), though of course if a student wishes to share with some classmate his or her grades on some items or the course, that is up to him or her.

Note that, very informally put, the quiz/homework dropping in some sense covers 286 students for 4 quizzes and 2 homeworks of misses, and 486 students for 2 quizzes and 1 homework of misses. However, I would emphatically urge each of you to attend every class (except when sick) and do and hand in every homework; you will learn far more and enjoy the course far more; and that will let the drops just end up dropping whichever quizzes or homeworks you happened not to do well on, rather than ones you skipped outright.

Beyond that, in grading the course, the 286 students will have their grades assigned with consideration of the fact that they are taking the course as 286. (Thus, 286 students should not view themselves as being in competition with the 486 students—though actually no one should view him- or herself as being in competition with anyone else in the course.) All undergraduates in the course (except those who did excellently in CSC280) should speak with me immediately after the first class, so we can get a handle on exactly what your background is as it relates to the current course, and whether you are ready for this course.

We will use Blackboard to store and to share with you the grades on each item. (If we enter your grade in Blackboard incorrectly as an overly low grade, you have the same time frames as in the regrading-request information to get to us your request that we correct that within Blackboard. Thus you’ll want to frequently check Blackboard. So, except for the last 10 days, you have a 48-hour window after something is handed back in class to let us know by email to “cs486” of any case where we simply entered the wrong number—for this case, we will not regrade your entire quiz/homework/exam, but rather let us know within the window by email, and include a scan of the cover page that shows the grade we wrote but didn’t correctly enter.)

This course is available for audit credit, but only with my permission, so if you want to audit this course, please do make sure to talk with me (by email or on the first day of class).

**Class Attendance:** Required.

**Academic Honesty:** On all aspects of the course, it is very important to follow appro-
appropriate norms of academic honesty and professional conduct, most importantly including those regarding plagiarism; do not plagiarize. Please see the link from the course’s main web page to the school’s site on academic honesty. And note carefully the rules about what you can and cannot do/discuss together with classmates (note the discussion at the start of the section “Homework Preparation/Class Participation” of this document) and the rules on what notes/etc. you can/cannot have during quizzes and exams.

Quizzes, Tests: No makeups (not after the fact; not before the fact). No exceptions (except for religious holidays discussed long in advance\(^2\) or unless you have a letter from a convincing Dean). As a bow to sicknesses, broken cars, varsity events, conferences, and other compelling excuses, each 486 student will have his or her 2-lowest-quizzes/1-lowest-homework dropped (but no more, even with good excuses, unless you have a letter from a convincing Dean). As a bow to sicknesses, broken cars, varsity events, conferences, and other compelling excuses, each 286 student will have his or her 4-lowest-quizzes/2-lowest-homeworks dropped (but no more, even with good excuses, unless you have a letter from a convincing Dean).

The quizzes will very often or usually be surprise quizzes.

Pencils may not be used on anything you turn in. Please use only black or blue pen on handwritten turn-ins (in-class quizzes and exams, and any homeworks or take-home quizzes or exams that you do handwritten), and even in computer-generated text (such as if you do your homework answers on a computer) please don’t use the colors red or purple.

By the way, if you see in Blackboard a 0.1% as your grade on a quiz or project, what that means is the following: If you don’t submit something, we of course record a 0.0%. But if you hand something in and get a zero (or even any grade between 0 and 0.1%), we will often record it in Blackboard as a 0.1%, so that I can see that you did hand it in.

There will be two midterms. The first will be an in-class exam. The second midterm might be the same or might be an oral exam or might be a take-home exam done on your own or (most likely, at least if the class is going very well) might be a take-home project in the form of tackling and presenting some topic (some Hem-Ogi chapter) in groups or might be some multi-part combination of these or other elements; which it will be will be announced ahead of it. There will not be a final exam.

The first midterm and all quizzes are closed-book unless they explicitly say otherwise. The first midterm and the quizzes are also closed notes, except for the one sheet of cram-notes prepared by yourself, as discussed elsewhere. The second midterm will be closed-book, closed-notes, if an in-class exam or an oral exam, but will be open-book, open-notes, closed-people if a take-home exam.

\(^2\)To be explicit: You should, no later than September 4, noon, send me an email if any of the class days fall on days where due to observance of a religious holiday you will not be able to attend; in that email, you should please let me know all such days for the entire term. If you have a religious conflict told to me by the above date, I'll regarding the quiz/exam give you a makeup (perhaps oral or perhaps written) exam or will simply try to avoid having the exam on that day. If a homework falls due on a religious holiday, you should take that into account and make sure you nonetheless turn it in on or before the deadline; you may email your homework hand-in to “cs486,” no later than the deadline of course, as a pdf, if for some reason (religious holiday; illness; etc.) you cannot attend class on its due date to hand it in yourself.
Anyone with a documented disability for which accommodation is relevant to this course should please have the appropriate university office inform me of this and the related accommodations immediately (and should please speak privately with me after the first class so we can start on the logistics related to those accommodations).

Note that a quiz may be on material that is related to homework/class/etc. but that you have not seen before.

**Regrading:** If you want some quiz/homework/midterm-that-is-an-exam regraded (if Midterm II is a group project, I’ll directly grade you on it and regrading won’t apply), you must notify the TA (only via the email address “cs486” in the domain cs.rochester.edu—not via his personal email address—since “cs486” sends it to both him and me) of that via email within weekday 48 hours (Sat. and Sun. do not count against those) of it being given back, along with an emailed explanation of what you feel was graded incorrectly, and an emailed color scan (B&W is ok if you don’t have access to a color scanner) of your entire graded item (all parts of it—not just what you are asking for a regrade of). Note that the entire quiz/homework/exam that you are asking to be regraded may be regraded (not just the issue about which you are asking), and the grade may move either up or down. We will usually have your regraded paper back to you by the next class or the one after. If you are unhappy with the TA’s regrading, you may within 24 hours of getting it back from the TA repeat the same procedure as above (except adding an explanation of why you think it is still misgraded, and including in the email’s subject field this string: “RE-REGRADING REQUEST”); again, do be aware that other parts may be regraded and your grade may move up or down.

The only exception to the above time limits and scheme is that during the last 10 calendar days before the last day of classes, anything on which you want a regrade (and there is no re-regrading option during this period) has a single 24-calendar-hour-after-the-class-where-it-was-available-for-return time limit for being submitted for regrading (so look over things given back during the last ten days within the first 24 hours of getting them back, please).

**Texts:**

(required) Bovet and Crescenzi, Intro. to the Theory of Complexity Classes, the online edition—NOT the earlier printed edition.


(recommended) Papadimitriou, Computational Complexity.

Places like Amazon and so on have the required Hem-Ogi and the recommended Pap texts (but please do be aware, see below, that I have asked the library to put their copies on reserve for our course). Bovet–Crescenzi is kindly made available online by the authors at

http://piluc.algoritmica.org/books/itlcc

(look at the bottom of that web page to find the link to the pdf of the book).
Also, your own notes (whatever notes you take in class) surely will be useful to you.

**Books on Reserve:** On reserve, for this course, at Carlson Library, are quite a few books, including the above books, texts covering some or all of course’s topics, some more advanced (and less advanced) complexity books, some review books on discrete mathematics, and some just-plain-interesting books that I thought that you, as emerging computer-science researchers (and writers), might enjoy. Note that though the course is CSC286/CSC486, the library may list the books under the reserve list of one or both of those numbers. (Note: As of when I’m first writing this, the library still hasn’t yet processed my reserve request, but I trust they will very, very soon.)

You can usually get to the library’s list of reserve books for our course, and the status of each, through the Blackboard system (click on the “Reserves” button in our course area), or perhaps alternatively directly through the library’s own online catalog system.

**WWW Site:** You are expected, as part of taking this course, to visit the course web site http://www.cs.rochester.edu/courses/486/fall2015/ frequently. (i.e., wise would be to peek at it relatively often each day—it makes a good homepage for your browser!). *Be careful to make sure your browser isn’t caching and showing you an old version that you previously visited (browsers love to do that).* The web site will be the path that I will use to post homework assignments (and my quick description of what the topic of each past class was). It also has much other information, not just pointers at its end, but also within the day-by-day listing—both as items and as Notes inside each of the days. (The web site’s Notes and BB announcements are the two main paths used for communication; there is not a hard and firm rule as to which is used for what, but the general flavor tends to be that I often put things in Notes if they are things I want to be stay on the web site or are things that are part of the initial build of a day’s web-site block, and on the other hand for quick reminders/hints that come to mind after I do the initial build of a day’s web-site block I sometimes lean toward BB announcements.)

**Blackboard Announcements:** Many day-to-day reminders/announcements (aside from those made verbally in class) will be transmitted using the Blackboard “Announcements” feature. You can see these announcements within Blackboard. By default, Blackboard will *not* send you these by email. But you can, by changing your settings in Blackboard, arrange for it to do so (although the UR Blackboard administrator warns you that that option is not necessarily reliable; and so you even if you have it turned on you should very frequently peek at the course’s Announcements area within Blackboard). *You definitely should do so; I assume that you have, and that you thus are quickly getting all late-breaking updates!*

So, how do you turn on email notification of Announcements? Here is how, thanks to the UR Blackboard Administrator:

In your main Blackboard screen, click on the caret or “V” near your name in the upper-right, then choose Settings, then choose Edit Notification Settings. *Fixing your general settings won’t save you; the course ones override those in a bad way.* So under Edit Individual Course Settings, select this course, and then check the Email box at the top of
the email column, *and then make sure to click on Submit.* (If you get a big red error screen when doing this, wait a few minutes and try again at few times; Blackboard is prone to such errors but they usually go away in a few minutes when one retries.)

**Fun with Numbers:** Although the course is both CSC286 and CSC486, depending on which you are registered under, I’ll often just refer to it by one or the other of the numbers (or sometimes as CSC286/486 or CSC2/486).