

# EECS 70: Discrete Mathematics and Probability Theory, Fall 2014

## [Optional online warm-up problems](#)

We suggest that you work through at least some of these before starting on the homework itself. Since it will help solidify your basic knowledge of the material, you should find that it reduces confusion (and hopefully time spent) on the homework itself. Give it a try and see if it helps you. If nothing else, they're good study material!

You can find some study materials for the final [here](#).

## Instructor and Lecture

- Instructor: [Anant Sahai](#)
- Lecture: TTh 3:30 PM - 5:00 PM, Wheeler Auditorium
- Faculty office hours: Tuesdays 5:30 PM - 6:30 PM, 531 Cory
- Special office hours ahead of MT2: Sat Oct 25th, 2-4pm in 400 Cory

## GSI and Discussion Sections

Please click [here](#) for a list of the GSIs, their office hours, and their discussion sections. [This page](#) lists our readers (readers also hold office hours!). You can also view a calendar of GSI and reader office hours [here](#).

You are free to attend multiple sections as long as they aren't crowded. They will be covering the same basic material, but different GSIs might have different approaches to it.

## Homework parties: Thursday and Friday

### Locations:

- Thursday, 9:30am-12:00pm in the Wozniak Lounge (430 Soda Hall)
- Friday, 9:30am-12:00pm in the Wozniak Lounge (430 Soda Hall)
- Friday, 2:00pm-4:30pm in the Wozniak Lounge (430 Soda Hall)

Every week in the Wozniak Lounge, there will be a "homework party." This is completely optional. GSIs will be present in shifts as will some readers. Students are expected to help each other out, and if desired, form ad-hoc "pickup" homework groups in the style of a pickup basketball game.

The Woz is a relatively big space and if the weather is nice, we can also access the patio outside. But if the room is crowded, exercise good judgement and make room for others by leaving if you can find an alternative source of assistance. When the room is not crowded, people from the class are welcome to just hang out as long as they aren't bothering other people. Some social games might be available.

## Homework

Homeworks are always due at NOON on Monday unless otherwise specified below.

Self-grades are always due at NOON on the Thursday after the homework is due.

Please see [this page](#) for self-grading instructions. *You are not done grading until you successfully submit your grades using glookup.*

- [Homework #15 \(due 15 December 2014\)](#) ([grading form](#))
- [Homework #14 \(due 9 December 2014\)](#) ([vlab solutions](#)) ([vlab code solutions](#)) ([optional vlab solutions](#)) ([grading form](#))
- [Homework #13 \(due 3 December 2014\)](#) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #12 \(due 24 November 2014\)](#) ([grading form](#))
- [Homework #11 \(due 17 November 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #10 \(due 10 November 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #9 \(due 3 November 2014\)](#) ([Midterm 2](#)) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([Midterm 2 solutions](#)) ([grading form](#))
- [Homework #8 \(due 27 October 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #7 \(due 20 October 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #6 \(due 13 October 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #5 \(due 6 October 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #4 \(due 29 September 2014\)](#) ([vlab code](#)) ([Midterm 1](#)) ([Midterm 1 solutions](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #3 \(due 22 September 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #2 \(due 15 September 2014\)](#) ([vlab code](#)) ([vlab solutions](#)) ([vlab code solutions](#)) ([grading form](#))
- [Homework #1 \(due 8 September 2014\)](#) ([vlab solutions](#)) ([grading form](#))

## Notes (these will update)

There is no textbook for this class. Instead, the class lecture notes have been iteratively tuned through the years of different instructors teaching this course. Most everything covered in lecture will be mentioned in these notes. However, these notes are a work in progress. So they will change a bit before and after a given lecture. Consequently, it is a very good idea to at least skim the notes before attending lecture, and then read them over a couple of days after the lecture and reconcile them with your own handwritten notes.

- [Lecture Notes #24 \(Bonus\): The random coding argument: digital communication](#)

- [Lecture Notes #20: To Infinity and Beyond](#)  
Last Modified: 2014-04-30 23:22
- [Lecture Notes #19: Chernoff Bounds and the Central Limit Theorem](#) (slightly advanced)  
Last Modified: 2015-01-16 23:30
- [Lecture Notes #18: A Brief Intro to Continuous Probability](#) (some double integrals)  
Last Modified: 2014-04-17 01:21
- [Lecture Notes #17: Some Important Distributions and Coupon Collecting \(an interlude\)](#)  
Last Modified: 2014-04-17 00:29
- [Lecture Notes #16: Variance and the law of large numbers](#)  
Last Modified: 2014-04-17 00:16
- [Lecture Notes #15: Random Variables: Distributions, Independence, and Expectations](#)  
Last Modified: 2014-11-17 19:58
- [Lecture Notes #14: Applications: Hashing and Load Balancing](#)  
Last Modified: 2014-04-16 20:05
- [Lecture Notes #13: Independence and Unions](#)  
Last Modified: 2014-04-16 19:52
- [Lecture Notes #12: Examples and Stirling's approximation](#)  
Last Modified: 2014-03-30 01:57
- [Lecture notes #11: Counting](#)  
Last Modified: 2014-04-20 10:12
- [Lecture notes #10: Basic Discrete Probability](#)  
Last Modified: 2014-04-20 10:08
- [Lecture notes #9: Brief Intro to Probability and Coin Tosses](#)  
Last Modified: 2014-03-10 23:24
- [Lecture notes #8: Error Correcting Codes](#)  
Last Modified: 2014-10-24 13:59
- [Lecture notes #7: Polynomials](#)  
Last Modified: 2014-11-06 22:15
- [Lecture notes #6: Public Key Cryptography](#)  
Last Modified: 2014-10-27 10:10
- [Lecture notes #5: Modular Arithmetic](#)  
Last Modified: 2014-10-26 14:20
- [Lecture notes #4: Stable Marriage](#)  
Last Modified: 2014-09-09 01:39
- [Lecture notes #3: Induction](#)  
Last Modified: 2014-01-23 10:36
- [Lecture notes #2: Proofs](#)  
Last Modified: 2014-01-21 20:53
- [Lecture notes #1: Propositions](#)  
Last Modified: 2014-01-21 21:02
- [Lecture notes #0: A perspective on EECS as a whole and 70's role within it](#)  
Last Modified: 2014-04-20 10:54

## Discussion handouts

- [Discussion 15M](#), [Discussion Supplement 15MS](#)
- [Discussion 14W](#), [Discussion Supplement 14WS](#)
- [Discussion 13W](#)
- [Discussion 13M](#), [Discussion Supplement 13MS](#)
- [Discussion 12W](#), [Discussion Supplement 12WS](#)
- [Discussion 12M](#), [Discussion Supplement 12MS](#)
- [Discussion 11W](#), [Discussion Supplement 11WS](#)
- [Discussion 11M](#), [Discussion Supplement 11MS](#)
- [Discussion 10W](#), [Discussion Supplement 10WS](#)
- [Discussion 10M](#), [Discussion Supplement 10MS](#)
- [Discussion 9W](#), [Discussion Supplement 9W](#)
- [Discussion 9M](#)
- [Discussion 8W](#)
- [Discussion 8M](#), [Discussion Supplement 8M](#)
- [Discussion 7W](#), [Discussion Supplement 7W](#)
- [Discussion 7M](#), [Discussion Supplement 7M](#)
- [Discussion 6W](#), [Discussion Supplement 6W](#)
- [Discussion 6M](#), [Discussion Supplement 6M](#)
- [Discussion 5W](#), [Discussion Supplement 5W](#)
- [Discussion 5M](#), [Discussion Supplement 5M](#)
- [Discussion 4W](#), [Discussion Supplement 4W](#)
- [Discussion 4M](#), [Discussion Supplement 4M](#)
- [Discussion 3W](#), [Discussion Supplement 3W](#)
- [Discussion 3M](#), [Discussion Supplement 3M](#)
- [Discussion 2W](#), [Discussion Supplement 2W](#)
- [Discussion 2M](#)
- [Discussion 1W](#), [Discussion Supplement 1W](#),

## Weekly schedule

Time	Monday	Tuesday	Wednesday	Thursday
9:00				
9:30				
10:00	Sec. 2 - 105 Latimer Ena and Sean	Sec. 1 - 3105 Etcheverry Khoa	Sec. 2 - 105 Latimer Ena and Sean	Homework Party Wozniak Lounge
10:30	Sec. 3 - 3105 Etcheverry Chi Pang	Sec. 4 - 105 Latimer Shuo-Yiin	Sec. 3 - 3105 Etcheverry Chi Pang	
11:00	Sec. 14 - 85 Evans Preetum and Joseph	Sec. 15 - 140 Barrows Chi Pang	Sec. 14 - 85 Evans Preetum and Joseph	
11:30	Sec. 12 - 243 Dwinelle Ena	Sec. 5 - 310 Hearst Erin	Sec. 19 - 102 Latimer Vasuki	
12:00	Sec. 6 - 87 Evans Kevin	Sec. 13 - 3113 Etcheverry Vasuki	Sec. 6 - 87 Evans Kevin	
12:30	Sec. 7 - 75 Evans Eddie	Class	Sec. 7 - 75 Evans Eddie	Class
13:00	Sec. 9 - 87 Evans Sean	Sec. 8 - 75 Evans Penporn	Sec. 9 - 87 Evans Sean	
13:30	Sec. 11 - 85 Evans Steven	Sec. 20 - 71 Evans Ajay	Sec. 11 - 85 Evans Steven	
14:00				
14:30				
15:00				
15:30				
16:00				
16:30				
17:00				
17:30				
18:00				
18:30				
19:00				
19:30				
20:00				

Every week there are about 16 hours of opportunities for personalized face-to-face interaction with the course staff (faculty, GSIs, and readers) during their office hours and the weekly homework party.

In particular, you are encouraged to talk to the readers if you want any feedback regarding your assignments and the approaches that you took, and are still confused after reading the solutions, watching the video solutions, and talking with your own study group.

#### Due on Monday:

- Homework N due at noon, solutions posted soon after
- Homework N+1 posted in the evening

#### Due on Thursday:

- Self-grades for homework N due at noon

## Syllabus

Discrete mathematics and probability theory provide the foundation for many algorithms, concepts, and techniques in the field of Electrical Engineering and Computer Sciences. For example, computer hardware is based on Boolean logic. Induction is closely tied to recursion and is widely used, along with other proof techniques, in theoretical arguments that are critical to understanding the foundations of many things from algorithms to control to learning to signal processing to communication to artificial intelligence. Similarly for modular arithmetic and probability theory. EECS70 will introduce you to these and other mathematical concepts. By the end of the semester, you should have a firm grasp of the theoretical basis of these concepts and their applications to general mathematical problems. In addition, you will learn how they apply to specific, important problems in the field of EECS.

This course is divided into five main units, each of which will introduce you to a particular mathematical concept as well as its applications. The units are as follows:

- Logic and Proofs
- Modular Arithmetic
- Counting and Discrete Probability
- Continuous Probability
- Diagonalization and Self-Reference

These units will now be described in more detail.

#### Logic and Proofs

- Propositions and quantifiers
- Direct proofs
- Proofs by contradiction and contraposition
- Simple induction
- Strong induction
- The stable marriage problem

#### Modular Arithmetic

- Congruence relations
- Euclid's GCD algorithm and multiplicative inverses
- The RSA cryptosystem
- Polynomials over finite fields
- Error correcting codes

#### Counting and Discrete Probability

- Combinatorics and combinatorial proofs
- Probability spaces and events
- Conditional probability and Bayes' rule
- Hashing
- Random variables and distributions
- Expectation, variance, and Chebyshev bounds
- Polling and the law of large numbers

- Joint distributions and Bayesian inference

### Continuous Probability

- Continuous probability spaces and random variables
- Uniform and exponential distributions
- Normal distributions and the Central Limit Theorem

### Diagonalization and Self-Reference

- Cardinality of infinite sets
- Cantor's diagonalization proof
- Uncomputability and the halting problem

## Policies

### Grading

#### Homework

Homeworks will be assigned each Monday evening and will be due the following **Monday at noon**. NO late homeworks will be accepted.

Your lowest homework score of the semester will be dropped.

#### Virtual Labs

As a part of the homework, you will be asked to "virtual labs" that involve programming and plotting things. Knowing how to simulate and explore what actually can happen is an important skill and is very useful in learning the material and developing an intuition for it. To help students in this process, the course staff has prepared an [official EECS 70 virtual machine](#) that is running Ubuntu with the ipython and ijulia packages, as well as LaTeX, fully installed and ready for you to use.

Instructions on how to setup and use the virtual machine can be found [here](#).

Simply download the virtual machine and set it up using [software like VirtualBox](#) for your preferred platform. The virtual machine comes preloaded with some sample code in ipython. Ask in Piazza if you are having any difficulty.

For problems that have a significant programming component, we will usually provide template/skeletons in Python that students can use. However, solutions are generally accepted in any programming language that students prefer.

#### Homework Submission

Homeworks will be submitted electronically, as pdfs. Details of the online submission system are on Piazza. Homeworks may be prepared by hand, in LaTeX, or even using Microsoft Word (with equation editor --- but you're much better off learning LaTeX). If by hand, you will need to scan your work. Please see [scanning instructions](#) to scan to pdf.

Note that you will need to name your file "hwX.pdf" (e.g. "hw2.pdf") in order to submit it.

#### Homework Grading

We will have many readers for this class, but the primary way that the homework will be graded is by yourselves. Solutions will be posted online and then you will be expected to read them and enter your own scores and comments for every problem in the homework on a simple coarse scale:

- 0 = didn't attempt or very very wrong,
- 2 = off in the wrong direction or no clear direction,
- 5 = right direction and got half-way there,
- 8 = mostly right but a few minor things missing or wrong,
- 10 = 100% correct.

Your grades will be due the Thursday after the homework deadline and if you don't enter any grades by the deadline, **you are giving yourself a zero on that assignment**.

Note: all partial credit must be justified with a comment; without a comment, no partial credit will be allowed.

Just like we encourage you to use a study group for doing your homework, we strongly encourage you to have others help you in grading your assignments while you help grade theirs. This will also help you avoid self-favoritism.

The readers are going to grading a randomly selected subset of problems and so we will catch any attempts at trying to inflate your own scores. This will be considered cheating and is definitely not worth the risk.

#### Homework feedback

Readers are available to give you detailed feedback on your solutions as well as self-grading help during office hours. This is intended to help you improve your understanding of the material. Make sure you bring either a printout of your homework or your laptop with the file open for the ease of the readers. Check out when readers will be at office hours [here](#) or on the course calendar.

If you have any questions, please ask on Piazza.

### Exams

There will be two midterms and one final exam.

- Midterm 1: Tuesday, September 23, 8-10pm
- Midterm 2: Tuesday, October 28, 8-10pm, locations TBA

## Grade Breakdown

- Homework: 15%
- Participation\*: 10%
- Midterms: 20% each (there are 2)
- Final: 35%

\*You will be asked to fill out a participation form near the end of the term. Please refer to the [template](#) to better understand how you will be graded. We strongly suggest filling out the form throughout the term so that you can present a more complete picture of your participation.

Extra credit will be available for many creative activities. (For example: translate the key ideas in a lecture into Internet Memes, make a web demo for a particular concept, create your own YouTube video explaining a concept in a way that is complementary to the way it had been discussed in class, creating practice problems with solutions, etc...) Talk with your GSI in person or post on Piazza if you want to get feedback from the entire class.

## Course Communication

The instructors and TA will post announcements, clarifications, hints, etc. on [Piazza](#). Hence you must check the CS70 Piazza page frequently throughout the term. (You should already have access to the CS70 Fall 2014 forum. If you do not, please let us know.) If you have a question, your best option is to post a message there. The staff (instructors and TAs) will check the forum regularly, and if you use the forum, other students will be able to help you too. When using the forum, please avoid off-topic discussions, and please do not post answers to homework questions before the homework is due.

If your question is personal or not of interest to other students, you may mark your question as private on Piazza, so only the instructors will see it. If you wish to talk with one of us individually, you are welcome to come to our office hours. Please reserve email for the questions you can't get answered in office hours, in discussion sections, or through the forum.

In a class this large, it can be challenging for the instructors to gauge how smoothly the class is going. We always welcome any feedback on what we could be doing better. If you would like to send anonymous comments or criticisms, please feel free to use an anonymous remailer like [this one](#) to avoid revealing your identity.

## Prerequisites

We expect you to remember [the math you learned in high school](#). Sophomore mathematical maturity (a solid understanding of the material in Math 1A, 1B --- typically coupled with taking Math53 or 54 concurrently with 70), and programming experience at the general level of 61A, but this could also be that gained in CS10 or the Advanced Placement Computer Science A course (e.g., E 7). If you lack any of these prerequisites, you may only take the class with special permission from the instructor. Although most of the work in the class will be pencil-and-paper exercises, we expect the students to be familiar with reading and designing programs. There will also be simulation and plotting exercises for you to do. The programming will not be tricky or confusing, at least not on purpose.

## Discussion Sections

Please enroll in a discussion section via Telebears, if you have not already. You may only enroll in a discussion section that has space available: see the online schedule. Outside of your discussion section, you should feel free to attend any of the staff office hours and ask any of us for help. Unofficially, you are welcome to attend other discussion sections but only if there is physical room. Get up and leave if there are registered students waiting. Keep in mind that it will be difficult for a TA whom you see infrequently to give you a fair participation grade so regularly attending the same section(s) is encouraged.

## Collaboration

You are encouraged to work on homework problems in study groups of two to four people; however, you must **always** write up the solutions on your own. Similarly, you may use books or online resources to help solve homework problems, but you must always credit all such sources in your writeup and you must never copy material verbatim. We believe that most students can distinguish between helping other students and cheating. Explaining the meaning of a question, discussing a way of approaching a solution, or collaboratively exploring how to solve a problem within your group is an interaction that we strongly encourage. But you should write your homework solution strictly by yourself so that your hands and eyes can help you internalize this material. **You must explicitly acknowledge everyone whom you have worked with or who has given you any significant ideas about the homework.** Not only is this good scholarly conduct, it also protects you from accusations of being a jerk or free-rider regarding your colleagues' ideas.

**Warning:** Your attention is drawn to the Department's [Policy on Academic Dishonesty](#). In particular, you should be aware that copying or sharing solutions, in whole or in part, from other students in the class or any other source without acknowledgment constitutes cheating. Any student found to be cheating risks automatically failing the class and being referred to the Office of Student Conduct.

**However, we are very fair.** No student will be accused of cheating without a human being looking over their case. And nobody will be sent to Student Conduct without at least the head TA and Prof concurring that this is warranted and makes sense. Algorithms help us focus our attention, but decisions are made by compassionate human beings.

## Don't Be Afraid to Ask for Help

Are you struggling? We'd rather you approached us for help, rather than falling behind gradually over the semester until things become untenable. Sometimes this happens when students are afraid of an unpleasant conversation with a professor if they admit to not understanding something. We would much rather deal with your misunderstanding early than deal with its consequences later. Even if you are convinced that you are the only person in the class that doesn't understand the material, and that it is entirely your fault for having fallen behind, please overcome any feelings of guilt and ask for help as soon as you need it -- we can almost guarantee you're not the only person who feels this way. Don't hesitate to ask us for help -- we really do care that you learn!

## Accommodations for Students with Physical, Cognitive, or Psychological Disabilities

If you have been issued a letter of accommodation from the Disabled Students Program ([DSP](#)), please contact Professor Sahai as soon as possible to work out the necessary arrangements. If you need an accommodation and have not yet seen a Disability Specialist at the DSP, please do so as soon as possible.

If you would need any assistance in the event of an emergency evacuation of the building, the DSP recommends that you make a plan for this in advance. (Contact the DSP access specialist at 643-6456.)

## Illness

If you have a fever, do not come to lecture or discussion or office hours or to the problem set party until at least 24 hours after the fever has passed. Email the head GSI (Katie -- katie.the.headta@gmail.com) to let her know. If this forces you to miss a homework, we will drop an extra homework for you.

Similarly, do not attend a midterm if you have a fever. Please let us know a short time in advance if this is going to happen, and we will make appropriate accommodations.

For non-contagious illnesses, use your good judgement. But spreading contagious disease is just horrible manners if you can prevent it.

## Advice

The following tips are offered based on our experience with this course.

**Don't fall behind!** In a conceptual class such as this, it is particularly important to maintain a steady effort throughout the semester, rather than hope to cram just before homework deadlines or exams. This is because it takes time and practice for the ideas to sink in. Make sure you allocate a sufficient number of hours every week to the class, including enough time for reading and understanding the material as well as for doing assignments. (As a rough guide, you should expect to do at least one hour of reading and two hours of problem solving for each hour of lecture.) Even though this class does not have any major projects, you should plan to spend as much time on it as your other technical classes.

**Do the homeworks!** The homeworks are explicitly designed to help you to learn the material as you go along. Although the numerical weight of the homeworks is not huge, there is usually a strong correlation between homework scores and final grades in the class. (The most common denominator among people who do poorly in the class is that they skipped several homework assignments or multiple homework problems.)

Also, you must read the sample solutions. You may well learn a different way of looking at the problem, and you may also benefit from emulating the style of the solutions. (In science people learn a lot from emulating the approach of more experienced scientists.)

**Don't wait until the last minute to start homeworks!** A good practice is to read through the homework problems as soon as they are available, and let them percolate in your brain. Think through possible approaches while you are waiting in line, or stuck in an elevator, or whatever. Sleeping on a problem has often helped people to come up with a creative approach to it. Definitely do not wait until the night before it is due to start working on the homework.

**Take part in discussion sections!** Discussion sections are not auxiliary lectures. They are an opportunity for interactive learning. The success of a discussion section depends largely on the willingness of students to participate actively in it. As with office hours, the better prepared you are for the discussion, the more you are likely to get out of it.

**Form study groups!** As stated above, you are encouraged to form small groups (two to four people) to work together on homeworks and on understanding the class material on a regular basis. In addition to being fun, this can save you a lot of time by generating ideas quickly and preventing you from getting hung up on some point or other. Of course, it is your responsibility to ensure that you contribute actively to the group; passive listening will likely not help you much. And recall the caveat above that you must write up your solutions on your own. You are strongly advised you to spend some time on your own thinking about each problem before you meet with your study partners; this way, you will be in a position to compare ideas with your partners, and it will get you in practice for the exams. Make sure you work through all problems yourself. Some groups try to split up the problems ("you do Problem 1, I'll do Problem 2, then we'll swap notes"); not only is this a punishable violation of our collaboration policies, it also ensures you will learn a lot less from this course.