

- (B) Attend lecture with no distractions and actively take notes. If you miss a live lecture, watch the recording with no distractions, a printed copy of the Prof's handwritten presentation at your side, while actively taking handwritten notes of your own.
- (C) Attend discussion live and participate actively. (No laptops or phones.) If there has been a gap between lecture and discussion, take a few minutes to glance through your notes before discussion. If you miss a discussion, use the recording and the handout to do it yourself. Pause as needed. Don't just look at the released solutions without trying to do the worksheet. If there are sections marked practice on the worksheet, try to do those — especially if you find yourself getting stuck on HW later.
- (D) Read the course notes in more detail, take notes, and try your hand at the online practice problems for any material that you find even remotely hard to understand.
- (E) As early as possible, and no later than Tuesday given a Friday HW deadline, start on the homework giving yourself an initial time budget of about 20 minutes per problem. Work with no distractions: no phone visible, no laptop (except for jupyter parts), etc. Just you and the printed HW the way it would be on an exam. It is ok if you get stuck, the goal at first is just to get started: read the problem carefully, figure out what questions are asking, write out what you know, and start setting things up. If you get stuck, write out why/where you are stuck and move on.
- (F) Meet with your group and/or attend HW Party to understand how to engage with the problems. If you're all stuck on something, ask for help by flagging down a member of course staff in HW party or posting on Piazza.
- (G) Take your notes and scratch paper from your group or HW Party and use them to help you write up your HW on your own. Again, a distraction-free environment is very important. There's also no point in getting bogged down in any one problem. Move on to another HW problem where you might be able to make progress. Also, set a total time limit per problem (say 3hrs) and just stop working on that problem at that point.
- (H) When the solutions come out, read them and self-grade your homework. If there is a discrepancy, then read the relevant solution very carefully to make sure you understand. Take notes on the solutions and then close everything to redo the problems that you didn't get perfectly the first time. Ideally, this redo will be done without looking at your solutions notes. If you get stuck redoing the problem, then look at your notes from the solutions. If you're still stuck, go back to read the solutions more carefully and augment your notes. Once done, close everything and redo the problem on your own.
- (I) For labs, make sure you have done any problems on the HW that say that they help support labs.
- (J) Skim the lab materials once they are released, ahead of coming to your lab section on time.
- (K) In your lab section, work diligently with your lab partner, asking for help from your classmates and course staff as needed.

We believe that following the above process diligently should nearly guarantee that you learn the material for the course. Moreover, the above approach can be adapted to other mathematical/modeling-oriented courses as well — even if they don't force you to self-grade your homework and reward redoing problems that you didn't get the first time, these remain very useful study tools. We also know that students are diverse, and so for some of you, minor tweaks on the above are appropriate. For example, if you find that you learn much better from written material than oral material, you might want to move reading the notes in detail above attending lecture and discussion.

As an adult, you are of course free to do things differently. But we can't support you if you do. You'll be on your own. Each of the required components of the course do different work: e.g. discussion can't and won't recapitulate lecture. There is some redundancy across the official notes, lecture, and discussion — but this redundancy exists to help students who didn't get something perfectly in one venue. The course can't give a personalized tutorial to each of the 1000+ students in the class.

Diagnostic FAQ

To make all this even more concrete and actionable, let's actually get into the details and treat this like a diagnostic exercise for someone having difficulty. We'll do this using a sequence of questions.

- 1 *Are you printing out the homework single-sided and working on it using scratch paper, with no laptop, phone, or tablet in sight? Do you have a printout of the notes available to you for reference (not looking online)?*

If you aren't following our simple HW process recommendations, there isn't much we can do.

We have reasons to recommend these things, but you're of course free to do what you want. Just understand that the consequences of doing what you want might not be the results that you want.

Why do we say this? Do we hate trees? It is just that we want you to be able to use your visual field and spatial memory while minimizing distractions. You're human. Don't create temptations for yourself.

Students should definitely be taking handwritten notes from the course notes, and should have these handwritten notes include references to page numbers and sections of the page in the original course notes. These complement the original course notes.

If you don't have a printer, and can't use the printers in Cory or Soda to which you all should have access, the HW PDFs themselves should then be rendered using a maximized window on your computer that you can look at. Depending on the length of the specific question on the HW, you might want to consider copying out the entire problem onto a piece of paper. You **always** want to copy out the essential details onto a piece of paper — basically take notes for the problems. This way, when you find yourself at a point where you have to read the course notes, you can switch your computer to be a maximized view of the notes and still let yourself keep the problem in sight.

In general though, you are better off using paper for anything you can. Tablets are just too small and there's a subtle loss of spatial context and impingement on your working memory when you scroll in a tablet as opposed to turning your head to take in another page of information on paper in your visual field. This doesn't matter for some people, but for many, this tiny extra load on working memory causes a significant loss in performance.

- 2 *Are you attending lectures synchronously? Are you taking notes? Are you attending and participating in discussions?*

If not, there isn't much that we can do. The course has required lecture **and** discussions for a reason. It really doesn't matter **at all** whether lectures or discussions have not worked for you in non-mathematical courses. Mathematical courses can be totally different. And even if they haven't worked for you in other mathematical courses, the nature of the mathematics in 16B could be different. You need to try.

Far more worrying is when you get caught in a catching-up spiral of doom. This is when you skip lecture or discussion because you are behind. All that does is make you further behind. Going to

lecture and discussion is a very good investment of your time. It helps with everything else. The course is a marathon, not a set of sprints.

We understand that Zoom lectures can sometimes be harder to attend, but now that we have left the “shelter in place” era, you are strongly encouraged to actually get together with your study group or even just a friend and attend the lecture together (or even just watch the recording together). Having a friend there in the room with you removes the distraction of texting them on the phone, and it gives you more confidence in asking useful questions. We’ve added a small lecture watching party to help as well.

The taking of notes is absolutely critical though. We have heard from many people that lectures on Zoom can be way more distracting than live lecture. Taking notes on paper during lecture (fullscreen) is a very effective way to counteract distraction.

3 *Are you reading the official notes in multiple passes? First, a quick read through to get the big picture. Then a more careful reading (potentially after attending lecture) to understand the details? Are you actively thinking about the examples that are given?*

If not, then you need to do this. The notes need to be read actively. Most students even benefit from taking notes while reading the notes. And of course, print them out while reading them. Feel free to also write on the printout itself.

If you find the style of a certain note as being not to your taste, think of yourself as a translator for yourself. Your own notes should be better for you. Everyone is different. This is one of the reasons that taking notes is essential. Your own notes are customized for you.

If you find yourself stuck, one thing that you can do is to make sure that you can rederive from scratch a proof or argument or worked-out example from the notes. It isn’t enough to nod along and say that you understand. The true proof of understanding actually being able to do it yourself. So do it yourself without looking at the notes. If you get stuck, then first glance at your handwritten notes from the course notes. If those help you, great. Keep going. If you’re still stuck, go back to the course notes themselves and add things to your handwritten notes as you understand things more carefully. Keep doing this until you can do the entire proof or example. And once you have done so, do it again without looking at anything.

Your goal in this process is not to merely memorize the approach in the course notes. It is to internalize the logic and way of thinking behind the course notes. That thinking is what you need on the HW and then on the exams.

4 *Are you doing the HW in a well-rested state, having first read through the entire HW? Are you using scratch paper to write out what you know and to explore the problem shortly after reading it? Are you avoiding all distractions and holding your attention on the HW?*

If not, you need to do this. The HW in mathematical courses is not compatible with being distracted. Nor is it compatible with simply sitting around waiting for a flash of insight to hit. (Putting the 16B HW aside and doing something else for a day can be helpful once you’ve started trying to do the problems because it lets your mind keep working in the background. This is not the same as just sitting around.) You need to think and explore systematically. It’s perfectly normal to try something that doesn’t end up working. You just have to back up and try something different. If you wait for knowing the right approach before even starting, you’ll just be paralyzed with doubt.

With those basics taken care of, if the course is feeling very hard and the HW is still regularly taking you a lot of time. It is important to go to the next level of diagnosis.

5 *Are you coming to the HW parties?*

There is certainly no requirement to come to the HW parties — they're not like the official notes, lectures, labs, and discussions which are mandatory. However, if you're finding that the HW is taking you a long time and you're not coming to the HW parties, it might be worth your while to come to the HW parties. You don't have to have a partner to come to the party, and being able to talk to others about problems that you're stuck on — sharing with them what you tried and why it didn't work and trying to figure out what does work together — can be really helpful in saving you a lot of time. Meeting with your study group is also really helpful and many people come together to the HW party.

It's best for you to have at least tried your hand at the problems (at a minimum, say spending 30 minutes reading the entire HW and then another 5-10 minutes per problem actually trying stuff on your own) before coming to the HW party. You'll get a lot more out of the HW party if you do that.

6 *Are you emotionally fighting the homework problems instead of engaging sincerely? Do the problems cause you to freeze up? Get angry?*

Internal emotional conflict doesn't necessarily follow reasonable timelines. There isn't much that we on course staff can do about this, except to gently point out that this might be where some people are having difficulties. Freezing up is a symptom which can sometimes be seen directly. But it might manifest as getting mad at the HW problems (who frustratingly don't respond in any way to you getting mad at them) or wanting to engage in a rant of some kind (against the problem, against the entire HW, against the material, against the course, against Berkeley EECS, against the world, etc.). You already know this isn't helpful, but the feeling comes anyway. And the blank sheet of paper stays blank.

If this is what's happening, there is actually something that you can do! First and foremost is to work with others. Good friends can listen, and actually be good friends and help you focus on what needs to get done instead of ranting about (even if the ranting is just happening inside your head) something that is entirely out of your control. But for many people, others taking the class with you can be even better than friends in this regard — because they can actually help bend your mind towards the actual problems that need to be done.

Another thing that you can do is allow yourself time-limited rants or wallowings. Set a timer for five minutes, and then proceed to throw yourself into feeling bad or being angry. Actually be sad or mad and just let yourself figuratively listen to whatever emotional energy wants to come out. **But then stop when time is up.** It is far better to be actually mad for five minutes than to be silently stewing and sabotaging your HW for hours. You can actually deploy this trick multiple times per day if necessary. (Even during an exam, except there, you need to do it quietly.) If it helps, think of it as an emotional bathroom break. However, if you can't stop when time is up, then something more serious might be wrong and it might be good to seek professional help at Tang. (They can also tell you many strategies that can help, including how to use physical exercise to dissipate excess emotional energy.)

7 *Are you trying to do everything alone?*

As written above, this might not be the best strategy for you. It is certainly important to try and start the HW on your own and to write up your results on your own. But in between, it can be really helpful to work with others. **When someone asks a question and someone else answers it, the person who is answering the question is actually getting the better end of that win/win deal!** So don't feel guilty about sincerely talking to someone about the homework — you're not hindering

them. The opposite is true. Also, understand that it is fine if all you have to share are some examples and attempts that didn't get anywhere. The important thing is getting started and exploring.

HW Party is great if you don't have a study group, everyone is welcome there. You can also ask people there to meet up afterward to continue working on the HW. You're not alone. You are welcome even if all you want is to be in the company of your classmates. This is also why we strongly recommend students to fill out the study group formation form and to get an official study group.

Also remember the saying: "joys shared multiply, difficulties shared divide." So share. One of the most amazing things in the world is that when you are a good friend and listen to the difficulties and sorrows of your friends, the resulting tears in your eyes can actually end up making you feel better too. So listening helps both the person who is sharing and the one who is listening.

8 *Have you done the warm up practice problems at <https://eecs16b.org/hw-practice/>?*

It might seem counterintuitive to think that if HW is taking you too much time that you might want to do more problems. However, sometimes more is less. The online practice problems are designed to help you get started, along with the notes and the problems in discussion. The HW is usually aimed at a level or two above that. Consequently, spending an hour or so on the online practice problems (immediately after the relevant discussion or even after reading the HW problems over) can be quite helpful in making the HW overall take less time. The underlying principle is that a gentle ramp can be easier than scaling a cliff, even if the ramp seems longer. Build some conceptual momentum and confidence before starting the main homework problems in earnest.

Remember, if you got into Berkeley, you can definitely understand the material in 16B. You just don't understand it yet. The word "yet" is important.

It can be hard sometimes in today's environment to be able to ask questions about these online problems. Please feel free to ask on Piazza. We want you to succeed. If you see topics for which you don't see online problems, also feel free to ask for some.

9 *Are you reading the solutions with an eye towards understanding how you could have figured this out yourself? Are you redoing the problems sincerely?*

It can sometimes feel frustrating to have to spend time on the solutions from last week while this week's HW awaits and lecture and discussion have already moved on to additional material. However, there is a huge return on your investment to spending a few minutes reflecting on strategies and the thought processes that would've permitted you to figure out the answer yourself. This is because the same general strategies tend to work over and over in this course (as well as many others). Look at a problem. Write out what it is asking you to do. Explicitly write down all the concepts that might be relevant and why. Do an example or two. Ask yourself how/why a particular concept might apply. Explore. If it is a proof or derivation, ask yourself what kind of intermediate result you might wish for. Break down the problem into sub-pieces that you can attempt to make progress on. You need to reconstruct for yourself how you could've succeeded on problems that you didn't get. This way, you'll be able to do the next HWs more efficiently.

10 *Are you worried that all these disciplined approaches are great and all, but you don't have the time to carry them out in the real world?*

Please don't think that we do not have an appreciation for reality. The key to understanding how to balance short-cuts with the "long way" is to internalize the principle of what is sometimes called "The Skier's Rule."

Let's take a digression. Suppose that someone is considering going skiing. They have a choice. They can buy skis for \$500 or they can rent skis for \$50 a day. What should they do? If they buy the

skis, and then decide that they don't like skiing after the second day, they are out \$500 whereas they could've just spent \$100 in rental costs. If they keep renting, they could end up liking skiing a lot and go skiing for 30 days and end up spending \$3000 on rentals, when they could've just spent \$500. The problem is that they don't know in advance whether they're going to like skiing. On any day, they could end up deciding that they don't like skiing anymore. How can they possibly deal with this complete uncertainty?

A reasonable approach is as follows. Start by renting skis. And then, when you've spent as much on renting skis as buying would have cost, then just buy skis. If you end up stopping before the 10th day, you've rented the whole time and done as well as you could have done had you known in advance and had no uncertainty at all. If you end up stopping anytime after the 10th day, you've only spent \$1000 and are no more than a factor of 2 away from the optimal cost had you known in advance.

"The Skier's Rule" provides a conceptual template for navigating via shortcuts vs the long way. Basically, it says to try whatever shortcut you want for a bit, but then stop once you've spent the time that the long way would've taken and just do the long way. You can adapt the spirit of the rule to many situations. So, imagine you're faced with some circuit problem. You know that you can write out the equations systematically and solve them. You estimate that this will take you 15 minutes to grind out. If you want, you can spend a few minutes looking for a clever perspective or easier way. But don't spend more than 15 minutes on this. Just grind it out at that point. Similarly while doing a proof: if you see three possible things you could do and don't know which to pick, don't just sit and think forever about which path to take. If each path is estimated to take about 5 minutes to try, then definitely start just trying all three of them within 5 or so minutes of thinking.

The same philosophy applies to any shortcut that jumps out at you. When faced with a problem that involves a page of text to read. You might wonder if there's a way you can start without actually reading the problem. You estimate it will take 4 minutes to read the page of text. How long should you spend looking for a short cut?

The same applies to reading the notes. How long will it take? An hour? Two hours? If you want, feel free to try to do the homework without reading them. But don't spend too long being confused. In a reasonable amount of time, just sit and read the notes. If you want, you can apply the same principle repeatedly. First, just skim the whole notes. If still stuck, read it carefully. If still stuck go back and take notes. You get the idea.

The critical difference between time and money is that spending time is rate-limited in a way that spending money is not. What does that mean? It means that you need to think ahead if you want to take shortcuts and potentially avoid needless work. How long could it take you to do things the "hard way?" You will want to start the HW well before that much time before the deadline. The most efficient way to do the homework is to start early. That is what lets you tentatively skip things, knowing that you could always do them if the shortcut didn't work fast enough.

Finally, take advantage of structure to conserve your finite budget of willpower. It is frankly **much** easier to attend discussion synchronously and just pay attention (because there is nothing else that you can do once you are in that position — no temptation means no decisions to make which means no expenditure of willpower). Setting up recurring and regular meetings with others to work on 16B (or attend lecture together or even to watch the lecture video together at double speed) allows you to not have to make decisions. A degree of regimentation coupled with doing things with others is the easier path to discipline for most people. We're telling you that in 16B, discussions really do pay off. Trust us on it. Lectures pay off too. Yes, you have to pay the time, but depending on your life, that time might be less dear than having to make that decision every time.

In reality, there's another thing that's important to appreciate. You'll get better at doing things the hard way with practice. This will make you better at the shortcuts too.

11 *Are you overwhelmed with the feeling that so many seemingly different things are introduced in the course?*

The course is actually just a few core conceptual patterns repeated over and over again so that you can appreciate their power and versatility. However, we understand that it can sometimes seem overwhelming as new ideas seem to come in lecture, discussion, homework, and lab. The key to getting this feeling under control is to, somewhere, take notes for yourself that categorize everything you have learned into six basic groups:

- **Definitions and Notations:** this is where you note down any concept or object that has been defined for you, together with its definition and properties. New kinds of notation and models also should be captured here.
- **Key examples:** this is where you note down concrete examples that have been shown to you that are paradigmatic.
- **Problems:** this is where you note down new kinds of problems that you now know exist along with what the objective is.
- **“Recipes”:** this is where you note down systematic approaches to solve certain kinds of problems or achieve certain goals.
- **Theorems:** this is where you note down any mathematical findings that have been proven, together with the key ideas in the proof. Remember, just as in all the other categories here, these might have been introduced with little or no fanfare¹.
- **Techniques/tricks:** this is where you note down thought patterns, mathematical tricks, and similar ideas that haven't already fallen into the above categories.

You'll find that once you have characterized things you're learning into these six categories, there aren't that many of them. Giving things names will also help.

As you go, you might want to start linking the ideas you have seen together into a concept map that you draw for yourself, possibly with the aid of your study group. This will further help you stay oriented.

Conclusion

This is a somewhat long note, but we hope it helps. You are an individual. Don't judge yourself based on how long things take you. What matters is understanding the material. In today's times, we will add the modifier: please keep things in perspective. 16B is great and all, but there are plenty of things that matter more than understanding this material or your grades. Yes, we want you to work hard and grow. But we don't want you to break. Be safe. Take care of yourself. Take each day as it comes. We want you to succeed as a whole person.

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¹Sometimes, new things will show up in problems. This is intentional. Our goal in this course is to equip you with what you need to tackle new things. That can't happen if you never face new things.