

Six Steps to Effective Study Habits

(1) Actively participate in each class and recitation meeting.

Think, ask questions, answer questions, take notes, and stay focused on the class.

(2) Prepare summaries of each class meeting and review them frequently.

As soon as possible after class, identify the key points, and summarize them in less than a page. Putting ideas in your own words helps you digest them. Review your summaries frequently. This is also a great start on exam preparation.

(3) Start working on assignments right away, think about them over a period of time, and do them without searching for models to mimic.

Start working on assigned problems as soon as you can after class, when the material is fresh in your mind, and, over a period of several days, come back to any that you do not get right away. If you are still stuck after that, use office hours.

The first step to solving problems is getting the material in your mind. Flipping through the book or notes to solve problems is inefficient and it does not help you prepare for exams. Try to solve problems using your understanding of the material; only after that should you check yourself (or get hints, if needed) using the book or notes.

(4) Go to each class and recitation meeting prepared.

Review what was covered in the previous several classes and do every assigned problem. Be ready to ask any questions that you have.

(5) Use office hours, and come prepared for office hours.

Getting your questions answered as early as possible helps you understand all later material better, so use office hours to ask questions. Identify your problems as precisely as you can, and be up on as much of the background as you can manage.

(6) Spread your exam preparation over weeks.

Working consistently over several weeks to prepare for exams helps you absorb the material more. Work as many review problems as you can. Review your summaries frequently.

While it will take time to implement the steps above, you will find that this actually saves you time since you are using your time more efficiently. The following pages have a more in-depth discussion of these points and more.

Effective Study Habits

Why is this document important to you?

Without the information contained in this document, it might take you longer to realize what you need to do in order to perform to the best of your ability in this course. This document gives you crucial, time-tested information on study habits that you should apply throughout this course, starting on day one, thereby giving you the best chance to succeed.

Mathematics is cumulative; we build it step by step, and mastering one topic requires mastering and remembering those that came before it. Therefore it is essential to act on the advice given here from the very first day of the course, and throughout the course.

Some of the points made in this document, such as the importance of attending class and recitation, are probably self-evident, but discussing how these good practices enable your success might help you avoid the temptation to cut corners. Some tips may be new to you.

The advice given here is written specifically for introductory calculus courses, but the good habits you will develop by following this advice are easily adapted to, and will serve you well in, other courses.

Why might the approach you used to learn math in high school be inadequate now?

Compared with high school courses, university courses have less classroom time but cover more material, so you certainly cannot expect to learn everything in the classroom. This shifts more of the burden — indeed, most of it — to you. You are responsible for what you learn. University courses also have less frequent exams and a faster pace than high school courses, so each exam covers much more material. The quantity of material alone can make university exams harder, but you are also expected to understand the material more deeply. The deeper understanding that you are expected to attain should, for instance, enable you to synthesize what you learn and figure out how to apply it to situations for which you have not seen similar sample problems. Thus, this course demands much more of you, so you probably need to upgrade your study practices to match the demands.

Will you have time to implement these recommendations?

Good study habits do not take more time. In the long run, they save you time since the underlying theme is building and maintaining a solid foundation so you can work more efficiently and benefit more from each activity, and you do not have to take extraordinary measures to prepare for exams.

Poor study habits create vicious cycles: for instance, without a good foundation from attending class and participating in recitation, you need more time to do the homework, leaving less time to do the next set of practice problems, so your grasp of the next topic is shaky, and around and around again. In contrast, good study habits create virtuous cycles: having absorbed the main ideas in class and having reviewed your notes, you have a solid

foundation that allows you to do the practice and homework problems more quickly, so you are prepared for the next class and have more time to review and stay on top of the material. The study tips below work together and reinforce each other; the more of them you implement, the easier each activity is to do, and the more you benefit from everything.

Where to turn for help for problems caused by external factors.

Self-discipline usually suffices to develop good study habits. However, sometimes external factors, such as family crises or personal problems, play a big role in academic difficulties. Any poor academic performance that may result can worsen the burden that the problems create, so it is all the more important to get help as soon as possible. The GW Counseling Center can help in such cases; take advantage of their services. Their contact information: <https://healthcenter.gwu.edu/counseling-and-psychological-services>, (202) 994-5300.

Essential Steps for Academic Success

(1) *Attend class, arrive on time, and remain for the entire class.*

Attending class is the first step on the path to learning; nothing replaces it, not a tutor, not web pages or videos, not friends' notes, not office hours. Absences due to illness are valid, but otherwise you should be present. Missing a lecture deprives you of some essential ingredients: an overview of the material, explanations, and illuminating examples, all given from a coherent perspective that is bound to be reflected in the exam questions.

Not everyone grasps everything in a lecture, but it is far easier to absorb, or at least get a first exposure to, the material relatively quickly through a lecture than, for instance, by reading the text yourself. It is best to do both; after (or before) a lecture, you should read the corresponding parts of the book; you will likely find that the lecture gives you a perspective on the material that helps you understand the text. Also, if you do not fully understand the lecture, be patient with yourself; with practice you will absorb more, and the lecture will at least help you identify what you need to ask about.

It is important to be on time and, under normal circumstances, to stay in class through the whole lecture. Missing part of a class can make the rest incomprehensible. Lectures are carefully planned and present the material step by step, so if you miss the statement of a result, an explanation, an example, or the chance to ask a question you need answered, whether by being late or stepping out during the lecture, you risk diminishing your grasp of the whole topic.

Learning is a collaborative endeavor in which you have many critical roles. In particular, you really begin to learn and internalize the material only when you grapple with problems yourself, so it is essential that you seriously try to solve many problems. Lectures pave the way for that. So that you have the tools you need to solve the practice and homework problems, and so that you can derive maximal benefit as you wrestle with those problems, you must get the foundation that the lectures provide.

(2) *Attend, prepare for, and actively participate in recitation.*

As just said, to learn the material and be ready for exams, you must work many problems yourself consistently throughout the course (not just before exams). It is crucial that you do the assigned recitation problems, and attend and actively participate in the recitation. Ideally you will solve every problem in advance and in the recitation you can check the correctness of your work; more likely, you will attempt every problem, but get stuck on some, so you then know what you need to ask about. If you do not try the problems in advance, then you do not know what points you have difficulty with, so you cannot ask the questions that you need to ask, thus missing a valuable opportunity. Watching others solve problems that you have not attempted gives you at most a small fraction of the benefit that the problems can provide.

To prepare for recitation, seriously attempt every problem in advance, prepare a list of the questions about the problems that you want to ask the TA, review the class material so you know all results that the problems might use, and be ready to ask questions about any results that you need clarified. (See items (3) and (4) for tips on reviewing class material.) Bring your work on the problems to the recitation so you can check the correctness of your solutions and answer the questions that the TA poses to the class.

(3) *Prepare for class.*

To prepare for class, review the material in the previous class and do the problems that were assigned. Do the problems as soon after the lecture as possible; this is an ideal way to solidify your grasp of the lecture material while it is still fresh in your mind.

One way to review a lecture is to go through your notes soon after class (when the lecture is still fresh in your memory) and check whether you understand everything; if there are details to be filled in, fill them in; if you have questions, ask. A more thorough method is rewriting the notes in a neater and more organized form, filling in the details, and adding helpful comments and reminders. A third method that I highly recommend is given in the second paragraph under item (4) below.

Highly motivated students will also read the corresponding sections of the text before class to get more out of the lecture.

(4) *Review the material frequently so you stay on top of it; do not fall behind.*

Frequent review is essential since math is cumulative: each topic is used later in the course (and in other courses), so you must not forget a topic after moving on to new material; forgetting earlier material makes it harder to understand later lectures; without knowing the definitions, results, and techniques, you cannot succeed on the homework and exams. You should devote some time each week to working a few problems from earlier in the course so you stay fresh on all topics.

Prepare a summary of each class. For most lectures, a half-page or less of definitions, theorems, and outlines of proofs, perhaps with the key steps of an example, suffices. Much of the rest of a lecture is packaging that helps you understand the key points. Preparing summaries is an excellent exercise to help you identify what is most important and focus your thoughts on the essence. Do this soon after the class while the material is still fresh in your mind; this will help solidify your grasp on what you just learned. While not replacing notes, summaries make it easy to review the material frequently (perhaps daily for new material and weekly for older material). Your summaries will also serve as already-made study guides for your exam preparation.

Many students who fall behind never adequately catch up; they have gaps that haunt them later. Falling one class behind puts you at a significant disadvantage; falling several classes behind puts you in deep trouble.

(5) *Review your notes and read the text actively.*

Your approach to mathematics should respect the nature of the discipline: math is built one step at a time and can be understood by anyone who puts in enough effort. So, read

the text and review your class notes actively; pause at the end of each sentence, phrase, or step, and make sure you understand why it is true and relevant (however, also be aware that sometimes explanations in books follow the steps, so if you cannot work out why a step is valid, look ahead to see if it is explained a few lines later); if details are left out, fill them in. When reading the text and your notes, always have some paper at hand so you can work out details. (Some students find that course notes suffice, but all students stand to benefit from the examples and insights that the text offers.)

(6) *Do the homework, and do it as actively and independently as possible.*

Homework is not just about feedback and grades: one of its roles is to help you identify the questions you need answered in office hours. If you can do well on all the homework without help, that is great, but if struggling with the homework reveals topics you have questions about, I want you to ask your questions in office hours.

To get maximal benefit from homework, first get the material into your mind: review the class notes, rework class and recitation problems, and absorb the ideas. Only then are you ready to think about the homework. Doing homework by looking for and imitating similar problems, or by searching the web for assistance, is a symptom of not having adequately absorbed the material; those approaches will not serve you well on exams and they do not help you develop a foundation for using the material in new ways in this course or later.

Working with friends to a limited degree may help you solve a problem that you tried yourself first and got stuck on, but beware of getting too much help: being dependent on friends for your homework will not give you the mastery of the material you need to succeed on the exams. The same caution applies with tutoring; indeed, if you have a tutor, then either (i) the tutor should ask you questions to help you break problems down into steps that you can handle (and in the process you should learn how to break problems down into smaller steps), or (ii) the tutor should guide you through similar problems (tutors can cook up similar problems or use those in the text) and then at most oversee your work on the actual homework. Getting homework assistance from a tutor beyond that hurts you: falsely inflating your homework scores fails to lay a foundation for success on exams — exams make up the far greater part of your grade, so one cannot overemphasize how important it is to derive maximal benefit from each opportunity to prepare for them.

(7) *Start the homework at least a few days in advance and put enough time into it.*

Like physical exercises that tone your muscles and build your endurance, many homework problems require taxing effort that stretches your mind. Start the homework at least a few days before it is due so you are not rushed, and you can do it thoughtfully and benefit fully from the exercise. Understanding, thinking, and solving problems take time; give yourself time. Do not expect to solve problems in five minutes. How long students need to solve problems varies (a big factor is how well you absorbed the material), so be willing to work hard on any problem for at least, say, a half hour, especially if the problem requires putting together several concepts. (With practice and greater mastery of the material, you will be able to do problems more rapidly, as you will need to do on exams.)

If you struggle with a problem without success, I strongly recommend that, before seeking help, you try it again the next day — you might get it on your own by having had the chance to sleep on it and let your mind work on it in the background. If you get it by yourself, then you derive much more benefit from the problem, as well as more self-confidence and a sense of accomplishment. Only by starting the homework early can you apply this technique.

Also, work out the homework problems on a different piece of paper from your final write-up since only after you have solved the problem can you organize your thoughts and explain the solution well. Thus, do the homework in two stages: (a) solve the problems, then (b) work on writing them up clearly, concisely, and completely.

(8) *Seek help if you routinely do poorly on homework.*

All students are welcome to ask questions in office hours about homework before it is due, and asking such questions is especially important if you are not doing well on the homework. Poor homework scores are a symptom of a problem that generally leads to poor exam performance; do not ignore the symptom.

(9) *Use office hours if you need help, and be prepared when you use office hours.*

Because math is cumulative, it is important to ask all of your questions as soon as possible, whether in class or in office hours. Asking questions in a timely manner is the ounce of prevention that is better than the pound of cure (major work later to catch up while also not falling behind on new material). So, if you have questions, ask.

The instructor and TA should be the first people you turn to for help for the simple reason that we know exactly how the material is presented in this course; tutors know the subject, but they do not know, for instance, the explanations we give, the relative importance we give to different topics, and the examples we use. You are welcome and encouraged to use the office hours listed on the syllabus; you do not have to ask whether you can use those office hours; they are open to everyone.

All students are welcome to ask questions related to the homework and class material during office hours. So that everyone's time (including yours) is used wisely, you must be prepared when you use office hours. You must have seriously attempted the problems first; you must bring an attempt at the problem, not a blank page. Not having the statement of a conceptual problem in your memory is a sign that you have not thought enough about it. Also, before coming to office hours, make sure you know the statement of every theorem and definition that could be relevant; have these in your mind, not just in your notes. (Of course, you can and should ask questions about results and definitions if you do not fully understand them.) Also, you can expect to be asked questions in office hours; by asking you questions, we aim to help you learn to break problems down into bite-sized pieces that you can handle.

The role of the instructor or TA in office hours (and the role of a tutor, if you use one) is much like that of a coach: the instructor and TA can help you understand the concepts, identify your mistakes, see what you need to work on, and break big problems down into smaller steps, but you must do the work. Your coach does not lift the weights or kick the

ball for you. If your instructor (or tutor) does a sample problem for you, then you should immediately do a similar problem yourself to make sure that you really understood what you were shown.

(10) *Devote enough time to the course outside of class.*

Spending only two hours a week on this course, outside of class and recitation, is likely to limit a student's course grade to no more than a *D* or, at best, a *C*; for many, two hours is not enough time to do much more than the written homework, if that. Three hours a week, while better, is also usually risky. Most students need to put in at least five hours a week outside of class and recitation; many of the top students put in eight or more; students who are struggling with the material or struggling to make up deficiencies in their background also need to put in extra hours. Do not hesitate to put in the hours you need to succeed.

Class and recitation occupy three hours and twenty minutes, so the target of at least five hours outside of class is consistent with the following observations. Studying is a full-time job to which you should devote at least forty hours a week (your education has a major influence on your future, so putting even more time into courses is a wise investment). Forty hours divided among five classes gives eight hours per course (including class and recitation). Courses you find challenging should get more time.

The target of at least five hours per week is also consistent with an often-cited guideline, namely, two hours of work outside of class for every hour in class.

Plan your course schedule so that you have sufficient time for each class, and modify your schedule if needed. Especially if you have had difficulty with math in the past, taking this course while carrying an eighteen-credit load is probably unwise; with eighteen credits, unless the other courses are all very easy, you are unlikely to be able to put enough time into this course. For some students, if you are taking this course along with several other demanding science courses, it may be wise to take less than fifteen credits.

Also on the topic of scheduling, whenever possible, select your courses so that you have enough free time close to the end of each class so you can implement the recommendations in items (3) and (4) about reviewing your notes, writing summaries, and starting the class and recitation problems while the lecture is still fresh in your mind.

(11) *Spread out your exam preparation over a week or, preferably, longer.*

Learning to solve mathematical problems is not unlike developing musical or athletic skill, and anyone who has worked to become even moderately accomplished at music or sports knows the value of practice and spreading that practice over time. It is unrealistic to expect to master the material from eight or more lectures in just one day. At the very least, spread your preparation for each exam over a week or two. Two hours a day for five days, doing a variety of types of problems each day, gives your brain more quality time to absorb ideas and see connections, and so is far more beneficial, than ten exhausting hours the day before the exam. (Studying much more than ten hours for an exam is, of course, highly recommended.) Spreading out your exam preparation has another benefit: you will not have to stay up studying the night before the exam, so you can be better rested during the

exam, and being well rested and mentally alert is necessary so you can perform at your highest level.

You will master the material more fully and easily if you review frequently throughout the course. Follow the advice in item (4).

If effective time management is a challenge, it can be useful to make a study plan that lists the topics to be covered each day and the hours devoted to them.

Identify your weaknesses and what you find hardest; look for patterns of mistakes on your homework; start with those topics and make sure you return to them often. Practice all topics, but give most attention to overcoming your difficulties.

Some students find it helpful to practice in a test-like setting. To make your own practice exam, take ten problems of different types from the book, review sheets, or problem lists, and attempt to solve them (without the aid of books, notes, or friends) in the time you will have for the exam (75 minutes for a midterm, 120 minutes for the final).

Take great care to be prepared for the final exam since not doing so can lower your course grade significantly. The final exam covers material from the entire course, so even if each question is no harder than the questions on the other exams, the amount of material covered can make the final exam seem harder. Effective study practices pay off all semester, but probably even more so at final exam time, when your solid foundation, consistent work, and frequent reviews can help prevent you from being overwhelmed by the volume and range of material you need to have mastered. While balancing the demands of all of your courses, do as many practice problems as you can in the two or three weeks before the final exam.

(12) *Avoid all distractions in class and while studying.*

Are you fully focused in class, or are you tuning in and out while reading or sending text messages? Are you looking at the board, or are you doodling? Are you listening to the instructor, or are you distracted by friends? Do you do your homework, class preparation, and recitation preparation in a quiet place where you can concentrate, or do you have music or a TV playing? To fully absorb the material and get the greatest benefit from the exercises, you must really concentrate. Learning is not compatible with “multi-tasking”.

(13) *Make your classes your number one priority.*

An internship is a valuable opportunity and can help you establish useful contacts or even get a job after graduation. Money from a part-time job is nice (perhaps critical if you pay your own tuition). Sports scholarships can help pay your tuition. However, there is little point to taking courses if too many other commitments prevent you from deriving any more than minimal benefit from them. Prioritize your commitments to make sure that you get the education that you are paying for and that will serve you well in the future.

Time management is important for all students, but it is absolutely critical if you are taking on significant commitments beyond your course work. Set up a schedule, have a time slot each day devoted to each course, and stick to it.

(14) *Maintain the good practices discussed here, whether you are doing well or not.*

If you do well on the first exam, that is great and you can be happy, but be careful not to become overconfident. Examine why you succeeded. If your success is based on your hard work, then be encouraged and keep up the good work. If your success came from knowing much of the material from a previous course, then be extremely cautious: you need to take great care to develop and maintain the effective study practices discussed here so that when we cover material that is new to you, you will be ready to master it.

If you do not do well on the first exam, then discuss your performance with me and work harder to implement the tips discussed here. Only by sticking with it and working hard will you have a chance of turning the situation around.

A few more tips

While I would not call it essential, another technique that many students find useful is working in peer study groups (but note the caution in item (6) about being dependent). Indeed, one of the best ways to solidify your grasp on a topic is to explain it to others, so make sure you give, as well as take, in your study groups. One of your study group activities might be having each member explain a topic — the others can both learn and check whether there are gaps in the explanation — everyone can learn in the process. Also, putting the material in your own words and discussing it without referring to books and notes helps you make the material yours, so discuss the material with your peers.

I have said many times that a lot of practice (starting with working all assigned problems) is crucial. I should add that you should not be (unintentionally) deceived by the ease with which the TA and I solve problems; do not expect the problems to be so easy for you. When we were students, the TA and I worked hard to master these topics, and we have extensive subsequent experience, so we typically immediately hone in on the relevant techniques and ideas needed for each problem. When you first learn the material, you do not have such experience to draw on — only by solving a lot of problems yourself (not just watching others solve problems) will you develop sufficient facility with the techniques and an understanding of which techniques are relevant for which problems. So, watching us may make it look easy, but be aware that you need to put in a lot of hard work so you too will be able to solve problems in a way that flows naturally and easily.

Always practice good habits, even on the work that is not graded, so you reduce the number of careless mistakes that you make on exams. For instance, make sure you always use parentheses correctly; ask your instructor if you have any doubts about their use; incorrect use of parentheses can lead to mistakes in your calculations or incorrect final answers. Similarly, use notation (equal signs, limits, integrals, etc.) correctly.

Always maintain a positive attitude; that makes the course more pleasant for everyone.

Pitfalls to Academic Success

Most students who fail do so because of bad practices that are mostly (but not entirely) the opposites of the good study practices discussed above. The result: time and tuition are wasted, valuable opportunities are lost, and both the instructor and the students are dissatisfied. If you ever find yourself heading toward any of the pitfalls below, take this discussion as a serious warning and change your ways. Please, do yourself a huge favor and think twice (three times, four times, whatever it takes!), talk with your instructor and your academic advisors, and avoid these traps. Even some students who see themselves as conscientious and hard-working may fall into these traps — you must be completely honest with yourself and recognize when your own behavior hurts you. Give yourself the chance to succeed!

(A) *Not taking full advantage of lectures.*

- (i) *Missing class or frequently being late.*
- (ii) *Not reviewing class material and not preparing problems.*

See the discussion in items (1) and (3) above.

(B) *Not taking full advantage of recitations.*

- (i) *Missing recitation.*
- (ii) *Not preparing for recitation.*
- (iii) *Not actively participating in recitation.*

See the discussion in item (2) above.

(C) *Not taking full advantage of the homework.*

- (i) *Not doing homework.*
- (ii) *Routinely doing poorly on homework and not seeking help.*
- (iii) *Not using office hours when you have questions and difficulties.*
- (iv) *Not being prepared when you use office hours for homework help.*
- (v) *Relying on friends or tutors to complete the homework.*
- (vi) *Doing the homework by imitating similar examples in the notes and books.*
- (vii) *Doing the homework by searching the web for assistance.*
- (viii) *Expecting each homework problem to take under five minutes.*

Not doing homework assignments, besides lowering your course grade, denies you another key opportunity to get your questions answered before facing the exam problems. See the discussion in items (6)–(9) above.

(D) *Insufficient work outside of class.*

- (i) *Putting in too little time outside of class.*
- (ii) *Letting yourself fall behind, thinking you can catch up before the next exam.*
- (iii) *Taking too many credits in one semester.*
- (iv) *Ignoring class x while you prepare for an exam, or do a project, in class y.*
- (v) *Thinking “I did well on the last exam, so I can sit back until the next exam”.*
- (vi) *Thinking “I understand the lectures; that is enough”.*
- (vii) *Leaving exam preparation to a day or two before an exam.*
- (viii) *Not reviewing the material frequently.*
- (ix) *Not knowing definitions, results, and techniques in this course and its prerequisites.*
- (x) *Not preparing adequately for the final exam.*

See the discussion in items (4), (5), (10), and (11) above.

(E) *Dealing ineffectively with a failing grade on the first exam.*

- (i) *Not choosing between improving your study practices or withdrawing.*
- (ii) *Ignoring the course until the next exam.*
- (iii) *Dropping out without withdrawing.*

Those who do very poorly on the first exam must think seriously about whether remaining in the course is wise. The decision is the student's, and different students set different goals (some just want to pass, others want to preserve a high GPA); the instructor can only help the student evaluate the situation and see what recovery would require, including helping the student analyze his or her study habits. Talking with the instructor is highly recommended, but the decision and the responsibility for it are the student's.

Among the many factors that must be taken into account in a plan to significantly improve your performance is the fact that many students find the final exam more difficult than the midterms, even when no single question is more difficult; this is simply because of the volume of material.

Low scores are discouraging, but ignoring the class, and missing class and recitation, is self-defeating. The course structure aids learning; rejecting that makes success less likely. If you are discouraged, please talk with the instructor about how to get on track.

The worst thing you can do is cease working in a course but not withdraw; that guarantees an *F*. It is crucial to devise a plan to turn things around or withdraw.

(F) *Dividing your attention in class or while studying.*

See the discussion in item (12) above.

(G) *Putting sports, internships, part-time work, or other activities before your classes.*

See the discussion in item (13) above.

(H) *Having a harmful attitude.*

- (i) *Thinking that doing the work in the course is below you.*
- (ii) *Believing that what you learned in high school should suffice.*
- (iii) *Thinking that the course expectations are too high or the workload is too heavy.*

If your exam scores are not high, you clearly have much to learn from this course, so work hard. That applies even if you took a course with a similar name in high school. University courses rightly go a lot deeper and expect greater mastery of the material, so it is not uncommon for students who got an *A* in a similarly-named high-school course to struggle in a university course.

The expectations in this course, including the amount of work required, are set so that students will have a good understanding of the subject, and so that those who meet the expectations will have the skills and knowledge that are the starting point for success in courses for which this is a prerequisite. To become reasonably accomplished at any endeavor, you must work hard and challenge yourself, so expect to work hard and be challenged in this course.