

PMA Mathematics TA Manual

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This document has been prepared by the past and present TA Fellows with the input of TAs, teaching staff and support staff. It will continue to be revised every year and we welcome your input too.

In this document, we will cover:

- your role as a TA
- what teaching at Caltech includes
- specific information about recitations
- specific information about office hours
- specific information about grading
- information about other roles you may be involved with such as head TA for a course, or a lecturing TA
- how to successfully support students in your capacity as TA

If you have any further questions, always feel free to reach out to the current TA Fellow or head to <https://pmatas.caltech.edu/> where we have an extensive FAQ section.

- Elliott Gesteau (2024)

1 Introduction and responsibilities

Welcome to the mathematics department! In this document, you will learn about your responsibilities and expectations when it comes to teaching. In the US, your teaching role is called 'Teaching Assistant' or TA for short. This will be you! This document aims to provide some guidance and recommendations for how you can complete each task in your role as TA.

Teaching in the mathematics department

Teaching in the math department is (with very few exceptions) a requirement. Generally, you will teach undergrad courses in your first few years. Later in your degree, depending on scheduling opportunities and whether or not there is a professor who wants you as their TA, you may have the opportunity to teach graduate courses.

Undergraduate courses

In *undergraduate* courses

- there is a group of TAs teaching (first year courses can even have 8-10 TAs!)
- typical minimal TA job expectations include:
 - recitations (see pages 5,6)
 - office hours (see page 7)
 - grading (see page 8)
 - answering student questions via email or other online message boards (see page 8)
- typical additional tasks:
 - writing solution manuals to problem sets/exams (see page 9)
 - review sessions (see page 9)
- the professor may ask you to do other relevant tasks.

Graduate courses

In *graduate* courses

- there is generally only one TA
- there may or may not be a recitation
- typical minimal TA job expectations include:
 - office hours (see page 7)
 - grading (see page 8)
 - responding to student questions (see page 9)
- solution manuals are sometimes not prepared in favour of students going over previous problem sets in office hours

Responsibilities

- It is important to understand that this is a job, so unlike a course, you cannot fail or do poorly
- It is in the official Caltech rules for math grads
- The professor makes the rules and expectations, so be aware of what the professor expects
 - this may vary between courses
- In general, when responding to students (particularly to questions about administrative aspects of your course) please consult with the professor or Head TA of the course first
- All TAs in a course are employed as a group to complete all tasks, DO NOT expect to necessarily do an exact fraction of the tasks - you may be asked to help cover for another struggling TA

Other notes

- **You are paid for 20 hours of teaching work a week**, which is a lot more than students expect!
- You and your students are expected to follow the Caltech Honor Code
- If you have concerns about your students, fellow TAs, your professor, or your work conditions, please speak to the TA Fellow or to members of the PMA Student Programs Team, currently:
 - Nam Ung, PMA Director of Student Programs
 - Belen Maria Hernandez, PMA Undergraduate Affairs & Course Coordinator
 - Mika Walton, PMA Graduate Affairs Coordinator
 - PMA Student Programs Office website: <https://pma.caltech.edu/resources-programs/studentprograms>
- Remember that you may inadvertently help inspire students in their future study or career choices
 - so be aware that you are a potential role model
- Teaching is never a solved problem - continue trying to improve every year. Your students will really appreciate this as will your professor!
- Teaching experience is amazing (and necessary) for your future career:
 - for academia: essential as you need to submit teaching statements
 - for industry: teaching skills are transferable - management, collaboration, mentorship etc.

2 Checklists for teaching a course

Before/beginning of the course

In general, at the beginning of the course (a week or two before it begins) your professor will contact all the TAs and organise a meeting to pass on their expectations for the course. Tasks for you to do:

Find a copy (electronic/hard copy) of the textbook - often the department will have one for you

Read the syllabus and refamiliarise yourself with the topics that you will be teaching

Double check when your recitation time is and think of a good time for your office hours (you will have some leeway to pick this)

Each week during your course

Throughout the course, you are expected to always be aware of what was taught in lectures. Attending the lectures is an option although not mandatory. Before your recitation and office hours

read the relevant parts of the textbook / lecture notes

familiarise yourself with the problem set / exam (maybe even take some notes for office hours)

prepare notes (for yourself) for your recitation

complete any expectations set by the Head TA or professor - this may include completing any relevant grading, preparing solutions for the problem set, preparing recitation notes for the TA group.

If you have any questions about teaching

If your questions are about course content, please consult your Head TA or professor.

If your questions are about TA expectations, teaching advice, or interpersonal problems, you have the following resources:

- TA Manual (this document)
- PMA TA website: <https://pmatas.caltech.edu>
- TA Fellow
- Hearst Fellow (Matt Gherman)
- other TAs (particularly your course Head TA)
- PMA Student Programs Office (<https://pma.caltech.edu/resources-programs/studentprograms>):
 - Nam Ung, PMA Director of Student Programs
 - Belen Maria Hernandez, PMA Undergraduate Affairs & Course Coordinator
 - Mika Walton, PMA Graduate Affairs Coordinator

3 Recitations

Introduction

You are expected to prepare and perform your recitations completely yourself. Often you will have some guidance from the professor, but just as often you will need to evaluate what to include based on what was covered in lectures or the content of the problem sets.

There is no set style for recitations and it is always positive for students to see different styles. A *strong recommendation* is that the recitations should be somewhere between a formal lecture and a casual chat. You should be comfortable enough to lead a lecture-like explanation of concepts, but just as comfortable enough to take questions from students and potentially focus on topics that students are struggling with. You should have enough time each week to explain course content in more detail than the lectures, solve problems, and take questions from students.

Recommended structure

While the structure is up to you, here is an example that is generally very successful and appreciated by students:

- Opening Comments (3 minutes):
 - feedback from previous problem sets
 - recommendations from professor
 - other important comments about previous weeks' work
- Beginning of recitation (3 minutes):
 - reminder of what the main topics from the previous week were
 - state clearly what the main topics of the current week are
- Body of the recitation: (45 minutes) **three topics**, 15 minutes each, preferably as follows:
 - state relevant theory
 - explain how to use the theory in a problem
 - do a problem
- End of recitation: (5 - 10 minutes)
 - point students to relevant theory for other topics
 - take questions.

As you get more comfortable, feel free to deviate from this structure, but many experienced TAs never do.

Advice for things to do

- Be enthusiastic. This is often quoted as a large factor in students becoming interested in mathematics and interested in the course.
- Be encouraging. Students are often timid or uncomfortable or unsure in their own ability; encouragement is important in these cases.
- Be flexible. Particularly if students are struggling with certain topics more than others, it may be prudent to focus on those a little more.
- Speak clearly and slowly, and try to include the students rather than just staring at the board the whole time.
- There is nothing wrong with simplification, especially in a practical class. For example, for concepts like what it means to be open, closed, compact, a boundary, I just draw a bunch of sets and explain intuitively why one is closed, one is open, etc. Then I draw a bunch more sets and ask the students to tell me if they are open, closed etc. For the last 2 years they identified all the sets correctly. Not all math has to be written in Greek. English and pictures work too.

Advice for things to avoid

- DO NOT SCARE YOUR STUDENTS. Try to relate every new concept to one they understand clearly so that instead of being scared they actually feel comfortable. For example, everyone is comfortable writing the equation for a line as $y = mx + b$, they love this. So when you explain the equation for a plane, emphasize how similar it is to the line. The normal vector is just like the slope m , and the constant is just like the intercept b . Another example: when you explain Stokes' theorem, emphasize how similar it is to the regular Fundamental Theorem of Calculus. On one side of the equality is stuff on the boundary, on the other is stuff on the interior, you move from one side to the other by doing some derivative stuff. This is MUCH MUCH better than telling your students about how this has to do with differential forms and vector bundles and all this cool math stuff in your research. You will likely just scare them away. Leave these conversations to when your students ask you directly about your work and are clearly excited to hear it.
- DO NOT BE ANTAGONISTIC. Assume the students are being genuine if they are complaining about something, or if they say that they do not understand. It is NOT a judgement on your teaching or grading abilities. In cases like this try to explain the concepts in a different manner or explain in more detail why you graded the way you did.
- DO NOT BE CONDESCENDING to the students - they are still learning and are often going to get things wrong.
- DO NOT ASSUME ANYTHING ABOUT YOUR STUDENTS. This includes how good they are, or motivations for their actions. Students doing poorly on problem sets is not done to spite you!

4 Office hours

Every TA will hold an office hour every week. It is an hour of answering questions that the students may have. These questions could be about the lectures, about the problems from the problem set, about previous problem set questions, or even clarification about grading. Any questions related to the course are possible. But of course, **most questions will be about the current problem set.**

The style of office hours is usually quite casual and directed by the questions of the students, not by anything prepared by the TA. It is heavily discouraged to teach lecture-style, although if a student requests an explanation of a topic, you can take a few minutes to explain something in this form. Since the majority of questions will be about problems from problem sets, the most difficult thing is to manage student expectations. It is unfair to other students (and hence a violation of the Caltech Honor Code) to give solutions away. Students can be very insistent, but you should stay strong. What I recommend is to first **insist on each student showing what you they have done.** Often students gain insight into a problem simply talking about it out loud. Additionally, a student who is just there to get the solution will immediately be uncovered if they have nothing to show. Of course, you need to give them the benefit of the doubt in case they are just really struggling with the problem solving aspect of the problem. In a case like this, encourage the student to try the problem again, explain relevant concepts, give them feedback for their attempts and perhaps explain what kind of problem it is.

Usually, problems will be one of the following forms: easy - where you just apply a definition or theorem, medium - you may need to combine a few definitions/theorems, and hard - these problems may involve a creative trick alongside what is expected of medium problems.

To summarise:

- Style: casual problem solving session.
- Do Not: give away solutions.
- Do: explain, help, go through student solutions, motivate, etc.
- Insist that students present what they've tried before giving hints
- Problems will tend to be one of three types:
 - Easy: apply definition or theorem
 - Medium: combine a few definitions/theorems
 - Hard: may involve a trick/creativity

5 Grading

Grading is the most time consuming of your tasks and often described as boring. However, it is important not to take this task lightly or to be slipshod. In particular, this is the task most directly related to the grade of the students, and hence to them, the most important.

In order to be fair to all students, if you are grading a particular problem set you will be assigned (one or more) problems and you will grade *all* students for this problem and usually you will be the only grader for these problems. Therefore, it is **important to be consistent when you grade**. The best way to ensure this is to create a rubric for the problem. This is usually done alongside writing solutions for the problems you are grading. This will be entirely your responsibility; professors rarely include any guidance other than providing the total number of points available for the problems.

When writing the rubric, **be aware of the expectations in the course** - an analytical course may have higher standards for proof rigour, while a practical course may require just a brief justification/explanation. Ask your professor, consult the syllabus and confirm with your fellow TAs what the expectation is. I do not say this lightly - inconsistency here is what most student complaints are about. Your head TA has hopefully discussed this with all the graders in the course to ensure consistency.

Grading is entirely course specific. Graduate courses care less about students explaining fundamental concepts and focus more on the correctness of proof steps and making sure the student fundamentally understands what is required of them. Undergraduate courses (esp. freshman/sophomore courses) generally require students to include more details and cite all definitions/theorems they use. In return, I recommend including marks for attempting a solution, having a correct approach and for providing logically valid proof steps.

Last but not least, **you should provide feedback** (generally, small comments). If the solution is correct, simple check marks suffice, but if there are mistakes, some small indication of why it is wrong and what to do instead is recommended. BE succinct and encouraging, DO NOT use condescending/insulting language. So avoid words like 'trivial', 'easy', 'obvious', 'bad', 'ridiculous', 'ugh', etc.

To summarise:

- You write your own rubric - can be very course specific.
- Graduate courses:
 - can be more focused on correctness
- Freshman/Sophomore courses:
 - include marks for attempts
 - include marks for correct approach
 - include marks for good logical steps/explanation of steps
- Always include personalized feedback.

6 Other possible tasks

Every course is different and you may be asked to perform other tasks than what has been mentioned here. The following is a brief summary of other possible things to keep in mind.

Responding to student questions

- Responding to student questions can occur in a variety of situations:
 - during recitations
 - during office hours
 - via email
 - via online message boards, such as Piazza or Canvas
- The guidance here is very similar to what was written about office hours (see page 7), but in short:
 - be respectful
 - do not give away solutions
 - be encouraging
 - feel free to give hints where appropriate
 - if the questions are administrative, you may need to refer to the Head TA or instructor/professor
- Please keep correspondence course content related. If personal problems are brought up or discussed, please follow the guidance of the section called 'Student support' (page 11).

Online duties

Certain duties are always online and reasonably self-explanatory. These include answering questions via email or message board, recording grades on shared spreadsheets and posting solutions on the course website.

In unusual circumstances, the course may be moved online. In such a situation you may be required to perform recitations, office hours and grading. In such a situation:

- You would be teaching using the Zoom software provided by Caltech.
- Generally this is paired with some sort of whiteboard software like miro.com or OneNote or even the Zoom-included whiteboard. Tablets are ideal for this and can be borrowed from the library if needed.
- Some TAs prefer to prefer to prepare slides, but this is often a lot more work and you will likely still be solving problems in real time, so the previous point is likely to still be used.
- Stay vigilant in case students are trying to ask a question via chat or by raising their hand.
- Grading would be done with software such as Gradescope or Canvas.
- It is important to grade just as thoroughly as if it was on a physical homework set and always provide ample feedback.

Head TAs

- Head TAs lead teaching in a course that has multiple TAs.
- Generally, you will also be doing double duty (the work of two TAs) - in return you will not work one of the other terms.
- You will be responsible for communication between the other TAs and the instructor/professor. This often means sending administrative emails and organising TA group meetings.
- You will often be the first point of contact for students (before the instructor/professor).
- You are expected to do the majority of the administrative details of the course including setting up grading spreadsheets.
- You are expected to schedule and give review sessions before midterms and final exams.
- You are responsible for dealing with conflicts with in the course (between any combination of TAs, students and/or instructor). If things get too complicated, however, you will be passing things off to the TA Fellow (who may themselves refer this higher up the administrative totem pole).
- You will attend Head TA meetings with the TA Fellow (a casual atmosphere to discuss with your peers about how your course is going and getting advice on any aspect).

7 Student support

Higher education and Caltech in particular can be a very stressful environment for students at all levels. Statistically, close to 50% of Caltech students utilise mental health services at some point in their time here. Your students may be suffering and it is important to know what you can do to help.

Before we continue, it is important to remember that you are not therapists or doctors, so it is highly encouraged that, where appropriate, you refer students onto professional support. Equally, it is highly discouraged that you should try to solve problems that are not strictly speaking mathematical in nature. When students struggle it may be very difficult to notice. Symptoms of struggling often include the following behaviours:

- marked drop in grades/participation, especially if it puts them at risk of failing
- not submitting problem sets with no explanation
- regularly late problem sets (even if the excuses seem valid on their own)

Of course, if you additionally learn of any struggles via other means, be mindful that they may need help. However ever you come to suspect that a student may need support, please be encouraging and accommodating and let them know that you are concerned and that they may want to consider getting extra help. In such cases you should feel comfortable to give extensions, but such accommodations are only temporary.

Last piece of advice, before we look at the resources available to you:

- **DO NOT ASSUME** students are trying to take advantage of the system: mental health issues are often invisible and present differently in different people.
- **BE RESPECTFUL** and understanding.
- Caltech is small and so we **expect TAs to follow up with students rather than just let them fail** - this is very different to most universities.

Resources at your disposal

There are many resources that you can call upon. These include the PMA Student Program's Office, the CTLO, the Undergraduate Dean's Office and the Caltech Health and Counseling Center. The details are below.

- PMA Student Programs Office (<https://pma.caltech.edu/resources-programs/studentprograms>):
 - Nam Ung, PMA Director of Student Programs
 - Belen Maria Hernandez, PMA Undergraduate Affairs & Course Coordinator
 - Mika Walton, PMA Graduate Affairs Coordinator
- Center for Teaching, Learning and Outreach (CTLO):
 - The CTLO supports Caltech's multifaceted educational efforts, including undergraduate and graduate courses and curricula, formal and informal learning, and partnerships with PreK-12 teachers and students.

- Specifically for grad TAs, the CTLO has a large library of resources on teaching and teaching- adjacent skills, as well as experts who are always available for consultation and who also run a wide variety of workshops throughout the year. A more comprehensive list of the available help provided by the CTLO can be found on the CTLO website.
- website: <https://ctlo.caltech.edu/>
- **NOTE: If a student is really struggling, you can submit a CARE referral (either anonymously or not) at <https://caltechcares.caltech.edu/care-referrals>.** This alerts the Undergraduate Dean's Office and professional support staff will check in with the student. They will then have access to the following resources available through the Caltech Health and Counseling Center and the Undergraduate Dean's Office:
 - Caltech Health and Counseling Center:
 - therapists
 - occupational therapists
 - Undergrad Dean's Office:
 - the Dean can approve extensions at the highest level
 - the Dean can approve exam extensions
 - the Dean can approve various forms of incomplete grade (allowing a student to take more time or retake the class later)
 - the Dean's office runs a program of tutors that can give additional course help

Workshop

- There is a workshop for all TAs organised each term by the TA Fellow featuring a guest speaker.

8 Good luck

Good luck in your teaching career at Caltech! I sincerely hope it is enjoyable and fulfilling!