

OTIS Syllabus

Olympiad Training for Individual Study

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*Effective starting June 2018

§1 Overview

“It’s hard to do a really good job on anything you don’t think about in the shower.”

— Paul Graham

§1.1 Prerequisites

- You should be comfortable qualifying for your country’s national olympiad and be able to read and write proofs.
- You need to complete the math orientation packet (which you should have received by now) and submit it by the specified deadline.
- It is strongly recommended that you also work through the first four chapters of my textbook, <http://web.evanchen.cc/geombook.html>. This will cover fundamental olympiad geometry concepts such as angle chasing, radical axis, homothety, and famous configurations.
- It is a good investment¹ to learn L^AT_EX well in the summer before OTIS begins; it will pay back in spades when writing up solutions.
- Students will generally not be invited to OTIS after two full years of participation.²

§1.2 Summary

The training by default³ consists of the following components.

- Every two weeks, a **problem set** of approximately 9-15 olympiad problems (of which you solve some subset), most of which focus in one particular topic.
- Everyone or two weeks, an **online meeting** to discuss the problems and topics, usually over Google Hangouts. Typically this lasts around 75 minutes.
- Prompt communication (via email, Facebook, Hangouts, etc.) for questions etc.
- Every month or so, a set of two full-length **mock olympiads** (3.5 hours and 3 problems, USAMO/IMO style).

A crude estimate for the total time commitment might be **8-12 hours per week**, though this varies substantially between different students and between units.

§1.3 Dates

Start and end dates are done in semesters (following MIT).⁴

Problem sets and meetings are organized in two-week units on particular topics. Barring unexpected conflicts, snow days, apocalypse, etc. expect **seven units in the fall semester**, and **six units in the spring semester**.

¹This suggestion is actually from one of my past students, so I’m not just making this up.

²This is both for fairness, so that more students can participate, as well as limitations on my materials.

³Everything is negotiable, and I’m open to suggestions or comments.

⁴You may drop the training mid-way at any point, though obviously I would appreciate advance notice.

§1.4 Problem Sets

The most important part of the training is the regular problem sets.

You are expected to communicate with me throughout the week about any problems you have difficulty with (this should happen every week). A good rule of thumb is to **ask for hints after an hour with no progress**. When asking for hints, please describe the progress you've made so far, or approaches that you've tried and didn't work. See Section 2.4 for more on that.

The mock olympiads should be applied under olympiad conditions. In particular, one should use a single continuous block of time, and write full solutions to problems as one would on the USAMO.

§1.5 Payment Information

The rate is $\$80(H + 4)$ each semester (where H is the number of hours).⁵ Enrolled students should get a "Parent Information" handout with more payment details.

§2 Curriculum

§2.1 Units

The page

<http://web.evanchen.cc/static/otis-samples/synopsis.html>

contains a catalog of possible units (which is always changing, so may be slightly out of date). The choice of which units to cover is done by mutual agreement (usually I make a recommendation but let the student request any changes).

§2.2 OTIS-WEB

Starting in the 2017-2018 school year, OTIS has moved onto its own dedicated website⁶. The URL for creating an account will be emailed to you upon completion of the summer packet.

The website is sort of the central hub for all materials It will be used to manage the following:

- Lecture notes for each unit,
- Problem sets for each unit,
- Transcripts of meetings, and
- Your submissions to the problem sets.

Mock olympiads and HMMT problems are submitted separately, see below. (They are still listed on OTIS-WEB.)

Note that lecture notes for meetings are uploaded well in advance, and you are encouraged to skim through these beforehand. In particular, certain lectures may have associated reading you will need to do; these will be clearly indicated in the lecture notes PDF. **All materials are internal use only.**

⁵Reduced from $80(H + 5)$ starting 2018-2019, since my preparation time is finally starting to go down.

⁶Before, I used an ad-hoc Google Drive system.

§2.3 Problem sets

For each unit's problem set, you should write up solutions and submit problem sets by uploading PDF's to OTIS-WEB before the meeting, by using the **"File Uploads" link for that unit**.

Each problem set has 10-15 problems, but you're not expected to solve all of them: each problem has a weight (like [5♣]) attached to it, and you are aiming to solve a certain target score or more. This will be self-explanatory once you see your first problem set.

You only need to submit outlines of solutions, although full write-ups are certainly welcome if you have the time. I mostly check these only for sanity, rather than line-by-line.

As I mentioned in the beginning, I suggest typesetting your problem sets in L^AT_EX. The output is very pretty, you learn how to use L^AT_EX (useful later), and you now have digital copies of all your work. After all, given how much time you're spending on my problems, don't you want to keep an archive of them?

§2.4 (Important) Talk to me, I don't bite

I want to really stress the importance of keeping in contact with me, and in particular the importance of asking for help. The problem sets are meant to help you learn through practice, rather than judgment (of skill or time spent or whatever). A problem will usually teach you a lot more in the first one or two hours than in the six hours after that. So it's much better to ask for directions once you've hit a barrier, rather than being stuck for hours on problem 5 and then not having enough time to try problems 6-10.

Put more concisely, **the problem sets should feel interactive**. Of course this only works if you reach out to me.

Some more pointers:

- On a typical unit, a rough estimate is that you will need help on at least 1/3 of the problems, in the sense that you're unlikely to solve the problem no matter how much time you spend on it. (The actual constant varies a lot by person and unit.) That means that **in expectation you should be writing to me 3+ times per unit**. This is a lot!

(If you find you're consistently able to solve all the problems, consider asking me to make your curriculum more difficult.)

- You can contact me through any of Facebook, email, or Google Hangouts. I recommend one of the first two since I'll see those on my phone.
- Timing: I make an effort to try to respond to OTIS messages as soon as I see them, since I consider this to be one of the most important parts of my job. However I tend to sleep quite early (sometimes as early as 10PM ET) and so if you send me a message late at night I will probably not get it until the next morning. But if you send me a message during daylight hours, you might typically expect a response within about 6 hours.

If I don't respond to something within 24 hours, that is not okay on my part; please remind me.

- It's more convenient for me if you refer to a problem as "USAMO 2010/6" instead of "problem 3.10". (I have a lot of the years memorized by now, but the numbers keep changing.)

- Describing what you’ve tried so far (even things that didn’t work) is helpful. That will help me give you more refined suggestions.
- Don’t be afraid to ask for more directions if the first hint I give isn’t sufficient! (I tend to give conservative hints, to avoid spoiling too much.)

That +4 term in the semester payment is there for a reason. Make use of it!

§3 Meetings

§3.1 Logistics

We will use [Google Hangouts](#) for meetings. My Gmail address is

chen.evan6@gmail.com.

Please be online on Hangouts at the scheduled meeting time. We will do a video call.

Typically, I will have a \LaTeX document (in real time) which serves as a sort of “white board” for the class. Here is an example of part of a transcript from last year.⁷

IMO 2014 Problem 6

Example (IMO 2014/6)

Prove that for all sufficiently large n , in any set of n lines in general position it is possible to colour at least \sqrt{n} lines blue in such a way that none of its finite regions has a completely blue boundary.

Strategy

Color lines blue until stuck.

Proof this strategy works.

Look at a maximal configuration. Claim that in here, at least \sqrt{n} lines are blue.

So suppose there k blue lines and $n - k$ red lines. Then there are $\binom{k}{2}$ intersections of two blue lines. Moreover every red line is part of an almost-blue polygon. So can associate every red line to a blue intersection.

By “geometry”, at most two red lines per blue vertex. Thus

$$\binom{k}{2} \geq \frac{1}{2}(n - k) \implies k \geq \sqrt{n}.$$

□

Putnam example

The advantage of this setup is that we get a full transcript of the class that you can review on your own time. I usually upload these immediately after your class.

You can review the transcripts at any time later; the transcripts will be under the link “File Uploads” for each unit.

§3.2 What happens in a meeting?

Most students meet me every two weeks.⁸ We’ll start the k th session by

- discussing any remaining problems from the $(k - 1)$ st unit that you want to see,
- and then lecturing through the k th unit (well, more working through examples than me talking).

⁷Yes, I really type \LaTeX that fast.

⁸In some special cases, I might meet with a student every week instead of every two weeks. This can happen if a student is extremely fast and completes units in one week instead of two (often students aiming to medal at the IMO will do this). Another way this can happen is if the student is the only one available at an early time slot, e.g. 2PM ET.

§3.3 Meetings with teaching assistants

For bi-weekly students, I am often able to pair you with an assistant⁹ to meet with you in the “off” weeks that you don’t see me. **This is completely voluntary**. But the idea is that you could have weekly meetings this way, half of which are with me. (I do this because past participants have indicated this is helpful for finishing the problem sets, and more enjoyable.)

Often in these meetings, the TA’s would help work with you on practice problems. But you can with them about anything else too. Scheduling and payment is coordinated directly with the TA.¹⁰

§3.4 USAMO strategy session

This year, I will be scheduling one class¹¹ which is unusual in several ways:

- This class is optional. (It’s recommended for newcomers though.)
- This class is significantly shorter than usual (probably only half an hour or so).
- **The tuition is waived for this class.**
- This class will be run at a separate time than usual:
 - Just before the December TST for TST qualifiers, and
 - Just before the USAMO for USA(J)MO qualifiers.

I’ll send each group an email a couple weeks before in order to figure out the time. (If I fail to do so, please remind me!) The handout is <http://web.evanchen.cc/private/BMW-usamostrat.pdf> (already linked above).

The agenda for the class is:

1. For me to remind you yet again to not take the problem ordering too seriously,
2. To elaborate on some of the things in the USAMO strategy handout, and
3. To give me a chance to tell some instructive (or at least amusing) grading stories.

§3.5 Surveys

Throughout the year, I send three OTIS surveys by email.

- The first (longest) survey¹² is sent around the third unit or so.
- The second survey will be sent around the end of the fall semester.
- The third (shortest) survey will be sent at the end of the year.

You need not worry about these until you see them, but when you do, I really appreciate your feedback. Of course if you have comments at other times of the year, I am more than happy to take those as well.

⁹In terms of qualifications: typically I contract OTIS alumni who have won USAMO or made IMO.

¹⁰The rate would probably be the same. I don’t take a cut.

¹¹I used to always make this the last session, but this didn’t make sense since some people aren’t taking USAMO, some people are in TST, some people have taken USAMO strategy session already, et cetera.

¹²The nice thing about having a start-of-year survey (rather than an end-of-year survey like the rest of the world) is that your feedback will actually be used right away this year, rather than just helping future students.

§4 Mock olympiads and quizzes

Both the mock olympiads and the short quizzes will be graded through the GradeScope program. (You'll be set up for GradeScope when submitting the math orientation packet.)

The exams (and solutions) themselves will be shared in on OTIS-WEB. The solutions are actually available immediately, so you can read them right after taking the test, without waiting for grading.

You can disregard the “code-names” for the olympiads (one of “Foxtrot”, “Tango”, “Waltz”). These are for my internal use.

§4.1 Dates

There will be 10 tests (mock olympiads) in the school year, which come in pairs. The short quizzes are short-answer practice, each with 6 short-answer problems to be solved in 75 minutes. The dates for the practice exams are specified in Table 1.

Test Name	Released	Due
Tests 1 and 2	Aug 5	Oct 1
Tests 3 and 4	Sep 5	Nov 1
Quiz A	Oct 2	Nov 1
Quiz B	Oct 2	Nov 1
Tests 5 and 6	Oct 5	Dec 1
Quiz C	Nov 2	Dec 1
<i>Fall bonus final (optional)</i>	Dec 14	
Quiz D	Jan 2	Feb 1
Quiz E	Jan 2	Feb 1
Tests 7 and 8	Jan 5	Mar 1
Quiz F	Feb 2	Mar 1
Tests 9 and 10	Feb 5	Apr 1
<i>Spring bonus final (optional)</i>	Mar 14	

Table 1: Schedule for OTIS practice exams

I run grading at the beginning of each calendar month, but actually for all the practice tests that are still open — meaning there are two grading sessions for every month. For example, Test 3 is released on September 5, and due on November 1. So if you submit close to the deadline, you would get feedback by the first week of November. However, if you submit early by October 1, you would actually get the feedback by the first of October, before the test is due! (This would be around the same time most of the Tests 1 and 2 are graded.)

§4.2 Instructions for tests (mock olympiads)

Here are some instructions for submissions.

- Each test is three problems, 7 points per problem.
- There are **three levels: JMO, USAMO, and TST**. You should pick one of them to take.
- The time limit is **only 3.5 hours**. (This is deliberately shorter than the 4.5 hours used for JMO / USAMO; to help you get used to working under time pressure, and to make it easier to fit in your schedule.)

- Like a real olympiad, submit solutions on the given answer sheets. You can download the answer sheets from OTIS-WEB.
- You are encouraged to do the problems on the olympiad that you didn't take, but please do not submit those solutions on GradeScope; leave them blank.¹³
- When submitting mock olympiads, be careful to submit the right papers to the right problems. There are five distinct questions among the tests, of which you will only submit three.

The link <http://web.evanchen.cc/private/BMW-usamostrat.pdf> has some advice for mock (and real) olympiads.

§4.3 Instructions for Quizzes (short answer)

These are intended to give you bit of short-answer practice during the school year, to help prepare you for AIME, HMMT, PUMaC, MP4G, et cetera. (Indeed, you can expect most of the problems to come from there.)

- Each quiz is **75 minutes long**, and features **6 short answer problems**. Think of it like $\frac{5}{12}$ of an AIME, except probably harder.
- Use the answer sheet provided on OTIS-WEB. You will only submit short answers for grading. (Thus your score will be one of $\{0, 1, \dots, 6\}$.)

Most of the problems will be from past NIMO and OMO contests.

§4.4 Bonus final olympiads

You can request a final at the date in Table 1 if you have completed most of the previous OTIS exams due before then. (I'll send out an email to everyone eligible at that time). So, it serves as sort of an end-of-semester present (which is why it comes out around Christmas in the fall!).

The bonus finals are totally optional, and different in the following respect:

- You can do these as a mock exam if you want, or you can also just work on the problems for fun. In my experience, most people actually find the latter more enjoyable. (If you want me to take it under exam conditions and have them graded, then email me your solutions and I will read them.)
- The final problems are especially nice (or at least I think so).
- They are tailored individually (I hand-design these for each student).

¹³It seems that the GradeScope now lets you omit submissions for problems; this was not true before.

§5 Your to-do checklist

Here is a checklist of what's expected of you during the school year, to help keep track of the many parts.

- Before each unit:
 - Do any reading specified in the notes for that unit
 - Optionally, spend a little bit of time on the example problems
- During each unit:
 - Meet with me (or TA) at your scheduled time
 - Work on the practice problems for that unit
 - Keep me updated on your progress on the problems (see Section 2.4)
 - Submit outlines of solutions to OTIS-WEB (under “file uploads”)
- Before the deadlines in Table 1, submit:
 - Practice olympiads (usually two per month)
 - Quizzes (usually one every months)
 - Request a bonus final (optional)
- Throughout the year:
 - Respond to surveys I send
 - Schedule the USAMO strategy session before first major olympiad (optional)