Mathematics 281S: Problem Solving Seminar

Fall 2022 Wednesdays 5:15–6:30 pm Physics building 119

Professor: Lenny Ng
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Course web site: Assignments and other information will be posted to Sakai, `https://sakai.duke.edu/`. Please make sure you stay up-to-date with the information posted there. There is also a rudimentary course web page at `https://services.math.duke.edu/~ng/math281S/` but this is mainly for the benefit of people who aren't enrolled in the course.

Office hours: TBA and by appointment (set up in person or by email). If you want to set up an appointment via email outside of scheduled office hours, please keep in mind that I can't usually answer email immediately; on occasion it may take a day for me to respond.

Course synopsis: In this half-credit seminar, you will develop and hone your mathematical problem solving skills. Each week you'll be challenged with fun, recreational, and unconventional problems on a different topic. Topics will range widely through areas such as number theory, algebra, combinatorics, probability, and geometry, with a focus on areas that aren't typically part of a conventional math curriculum. Solving many of the problems will involve just as much creativity as technical knowledge.

Prerequisites: No formal prerequisites; everyone is welcome regardless of background! However, you should be willing to think hard and creatively about a variety of math problems, and to work with others. Previous experience with proof-writing (think Math 221, 401, 431, etc., or possibly background in math competitions) will be helpful but is not required; part of the goal of the course is to improve your proof-writing skills.

Please note that instructor permission is required to take this course (mainly so that I can learn a bit about the folks who want to take this class). If you'd like to enroll and you haven't already contacted me, please email me.

Textbook: There is no required text for this course. However, we will often be consulting the book *Putnam and Beyond*, 2nd edition, by Razvan Gelca and Titu Andreescu. This book is available for free as a PDF from the Duke Libraries web site; please make sure you get the 2nd edition.

I may also point you on occasion to a series of Youtube videos by Professor Po-Shen Loh (Carnegie Mellon); there's a link on Sakai (under "Resources"), or click here: `https://www.youtube.com/playlist?list=PLglvnRus7Jj5tZ42maZ3sdgvxIXTNx2D7`.

Pre-course homework: Even though there aren't any formal prerequisites, there *is* some background material that you should review if you're wondering if you're ready for this course: the proof-writing techniques discussed in Chapter 1 of *Putnam and Beyond*. If you're familiar with the techniques described there (proof by contradiction, mathematical induction, pigeonhole principle), then you're ready for this course. If not, then you may want to read Chapter 1, especially sections 1.1 through 1.3. We'll also review these techniques at the first meeting.

Also, this is a heads up that I'll be giving you a short (and fun?) assignment to do prior to the first class. Stay tuned; I'll email you through Sakai the week before the class starts.

Course structure: This is a working seminar. Students are expected to attend and actively participate in the class meetings. Most classes will consist of two parts: a portion where you work with each other to solve (or brainstorm ideas for) the assigned problems for that week, and a portion where I discuss the topic for the following week's problems. For the part where you're working on problems, you are expected to think about the problems beforehand, and to come to class with ideas for how to approach (or even solve) some or all of them.

Assignments and grading: There will be weekly problem sets consisting of a variety of problems around a theme of the week; each student will write up solutions to two problems of their choosing from the problem set. As mentioned earlier, you're allowed and encouraged to work with fellow students on solving the problems; however, you must write up your solutions on your own. In addition, I will assign a reading each week on the topic of the following week's meeting, and you are responsible for keeping up with the reading.

Problem sets will be due at class time, and late homeworks will not be accepted.

Your grade will be based on your problem sets and class attendance/participation. There are no exams for this course!

Duke community standard: All students must adhere to the Duke community standard.

Math 281S versus Math 283S: There is another, similar course, Math 283S "Advanced Problem Solving Seminar", which is more geared toward students interested in math competitions including the Putnam competition. Math 283S is also offered this fall. Compared to Math 283S, Math 281S is more designed for people who want to work on their problem-solving skills but without the pressure of competitions. I'd be happy to chat with you about which course would be more appropriate for you; it's not advisable to enroll in both. If you're interested in enrolling in Math 283S, please contact Professor David Kraines, dkrain@math.duke.edu.

COVID policy: Student health, safety, and well-being are the university's top priorities. To help ensure your well-being and the well-being of those around you, please do

not come to class if you have tested positive for COVID-19 or have possible symptoms and have not yet been tested. If any of these situations apply to you, you must follow university guidance related to the ongoing COVID-19 pandemic and current health and safety protocols. If you are experiencing any COVID-19 symptoms, contact student health (dshcheckin@duke.edu, 919-681-9355). Learn more about current university policy related to COVID-19 at `https://coronavirus.duke.edu/`.

To keep the university community as safe and healthy as possible, you will be expected to follow these guidelines. Please reach out to me and your academic dean as soon as possible if you need to quarantine or isolate so that we can discuss arrangements for your continued participationin class.

Under construction/acknowledgments: This is the first time I've taught this course, and only the second time the course has been offered at all. (There was a Math 281S before 2021 as well, but it was the course that's now called Math 283S.) This means that I may need to change things on the fly. I'll at least make sure that my expectations for you are clear, but I apologize in advance if things don't seem completely well organized.

Also, I owe a *huge* debt to Professor Colleen Robles, who taught Math 281S last year. She has graciously bequeathed her material, including problem sets, to me, and I'm planning to "borrow" them liberally this semester.

Collegiality: (this is lifted wholesale from Professor Robles!)

Adapted from the MSRI collegiality statement: The study of mathematics is challenging, often emotionally as well as intellectually; even mildly uncollegial behavior can have highly detrimental effects on another's ability to focus. In most situations, simple common sense and good judgment should suffice as guidance, but we appreciate that some questions of appropriate behavior can be more complex and subtle. It is important to be respectful and supportive of one another. Here are some ways you can help foster collegiality:

- Reach out to people in the class whom you do not know, and actively build new connections.
- Encourage mutual respect for similarities and differences in background, expertise, judgments, and assigned responsibilities, with the goal of establishing mutual trust between colleagues.
- Welcome diversity and encourage diverse opinions.
- Avoid demeaning others or aggressively challenging their competence or mathematical abilities.
- Refrain from promoting bias and stereotypes about race, nationality, religion, gender and sexual orientation, or other personal characteristics.
- Understand that behavior can have an adverse impact on others, even in the absence of malicious intent by the actor.