Master Syllabus for Math Labs (MATH201–206)

Course coordinator: Dan Dugger

There is not a traditional “master syllabus” for these courses, as the choice of course content will vary quite a bit from instructor to instructor in these Math Labs. Even different sections of MATH201 might focus on very different material. However, what I expect will be roughly the same in all Math Labs are the following course goals:

1. Help students gain experience in both talking and writing about mathematics.
2. Get students away from the idea that math is about learning algorithms and then showing that you can carry them out. We want to help students get on the path of asking questions about why things work, experimenting, and searching for explanations.
3. Give students some exposure to mathematics outside of the standard “road to calculus”.

Many Math Labs will be run like a math circle, or involve a flipped classroom in some way. This is not required, though.

We have a Dropbox set up with materials from several former Math Labs. For access, send me an email and I will add you. Also, I have webpages set up for my MATH205 and MATH206 from Fall 2017 here:

http://pages.uoregon.edu/ddugger/ma205_fall2017.html
http://pages.uoregon.edu/ddugger/ma206_fall2017.html

These pages have all the reading and writing assignments I assigned, and all the worksheets I used. The MA206 class went pretty well, but I think the material from the MA205 course got too difficult in the second half.

The Math Labs are set up to be 2-credit P/N courses. This means students should be putting in six hours per week, two of which are in the classroom. It is important to set clear guidelines on what will constitute a passing grade, for instance using some kind of point system. See my sample syllabus below for an example.

The following is a brief account of my experiences teaching two Math Labs in Fall 2017. I have a longer version of this I am happy to provide upon request.

1.1. What I did: I organized my Labs so that there was a weekly reading assignment to be done over the weekend, and on Monday the students had to hand in a short piece of writing (one or two paragraphs). Sometimes the writing was very open-ended (e.g. “Write about one thing you understood and one thing you didn’t understand”) and sometimes it was more directed (e.g., “Think about such-and-such problem for one hour and write about what you did to try to solve it.”) In addition to this, I had the students do 5 longer “write-ups” of 1-2 typed pages over the course of the
quarter, where they explained a concept or problem in more detail. They handed in 4 drafts throughout the quarter, I read them and gave feedback, and the students were required to revise them and hand everything in as a “Final Portfolio” that was due during finals week. Throughout the quarter, everything was graded on participation and not on whether anything was right or wrong. It was only on the Final Portfolio where they would lose points if things were incorrect.

I didn’t require that students type things, but I tried to encourage it. In particular, I gave students handouts on learning LaTeX and for one of the weekly writing assignments it was required that they use LaTeX. I wish I had focused a bit more of this, but even with minimal focus many students did learn to use the software and regularly handed in their work that way. The website www.overleaf.com seems to work well as an online LaTeX tool. The website cocalc.com is another one, but due to high usage that one gets slow in the middle of the day.

Classroom activities were spent discussing the readings, working problems in a math-circle type format, or (sometimes) lectures.

1.2. What didn’t go well: I felt a general lack of engagement from a lot of the students, and they constantly walked the line of doing just enough to barely skate by. Maybe the extent of this was not any more than a calculus class, but the nature of the course (and the small size) made it feel worse to me. If I asked that a write-up be 1–2 pages, many students handed in something that was just a couple paragraphs. Perhaps this was done on the grounds of “I know I’m not going to get penalized, so I will do just enough to get my participation points for this assignment.” It tended to frustrate me. My instructions for the first write-up said something like “write enough to show engagement with the topic, usually 1–2 pages will be sufficient” and what I found out was that the students and I had very different ideas for what “engagement” looked like. I tried to make later assignments much more specific.

Early in the class, I found that students had problems following instructions. If I asked them to write about a topic from the Week 2 worksheet, a few would choose to write about something completely different. The first Write-Up was a complete disaster, and I had to lecture them afterwards about following instructions and actually trying to do a good job. Things improved somewhat at this point, although for the final portfolio several students still did not follow my instructions or hand in their material on time.

After talking with some of the better students at the end of the course, I have some concerns about the P/N format—not enough to strongly argue against it, but enough to raise the question. I worry that without the incentive of a possible “A” grade, students just aren’t going to put much effort into the course. Maybe that’s okay.

When assigning final grades, I was not thrilled. I used a point system with 100 points and 80 constituted passing, but if I were to do it again I might make passing be 83 or 84. There were too many cases where students passed despite giving a very poor performance. Despite it being very easy to accumulate 90 points, very few students did this. I had about 25% of students in the 90-100 range, 37% in the 85–89 range, and 37% in the 75–81 range. These scores really should have been higher.
I ended up grading the final portfolio as follows. Each Write-Up was worth 5 points, with the rubric being

- 5 great
- 4 good, but a few minor errors
- 3 satisfactory, but needs improvement in either depth or correctness
- 2 deficient in either content or depth, but shows some signs of effort
- 1 minimal effort.

This accounted for 25 of the 26 points for the portfolio. The last point was given based on whether or not the student followed the instructions and handed the portfolio in on time. The average (and median!) grade on the final portfolio was 17.

The writings were, in general, somewhat depressing. A very few of the students were quite decent writers and handed in things that were enjoyable to read, but most of what students handed in had poor grammar or spelling, together with incoherent ideas. Lack of precision and poor explanations were typical.

I do think that good writing skills take time to develop, and mathematical writing has particular qualities that the students have not been trained in. I see the Math Labs as beginning instruction in this area, and it is unfair to expect the students to be experts. As the quarter dragged on I started to see the writing component of these Math Labs as more and more important. I don’t know how to teach these skills other than having them hand in drafts and getting feedback on them, but I think having this happen early in their math major is a very good thing.

One thing I noticed in the first Write-Up draft was that the writings contained a lot of “B.S.” Instead of jumping in and getting to the point, students would spend almost a whole page saying vague stuff about why what they were doing was important or fit into some kind of broader (but extremely vague) perspective. My best guess is that this comes from how they are trained to write essays in high school humanities classes. When I handed back these drafts, I gave them a lecture on how mathematical writing should be precise rather than vague, and should try to get to the point as quickly as possible. I included these kinds of comments as instructions for the second round of Write-Ups, and the situation improved somewhat.

Overall, I see the writing component of these Math Labs as sort of like toilet-training. It is miserable by nature, but life is much better because of it.
Note: This is the syllabus I used for MATH 205 in Fall 2017.

Title: Foundations MathLab

Instructor: Daniel Dugger

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General information: 2 credits; class meets each Monday and Wednesday from 5–5:50pm in 44 Columbia.

Prerequisites: None.

Short course description: Exploratory course in mathematics. Course focuses on techniques of mathematical exploration and discovery, the language of mathematics, and foundational issues. Topics from set theory and mathematical logic.

Long course description: A “set” is the mathematical term for a collection of objects—picture a bag with a bunch of objects in it. It seems to be a very simple concept, but in the nineteenth and early twentieth centuries people realized that one can build up almost all of mathematics by just starting with the theory of sets. Functions and numbers are all examples of special kinds of sets! People thinking about infinite sets also came up with some very, very strange realizations that were quite shocking—and will shock you when you learn about them.

Originally, people hoped that one could build all of mathematics from the theory of sets. This looked possible for a while, until Gödel stunned everyone by proving that this is not possible. In fact, he proved that it is not possible to reduce all of mathematics to a finite set of basic ideas. This is his famous Incompleteness Theorem.

In this course we will do a survey of set theory and mathematical logic. We won’t delve very deeply, but we will cover a wide spectrum of ideas.

Learning Outcomes: The goal of the MathLabs is to help students make the transition from the kind of “procedure-driven” mathematics that they see in K-12 education (and that to some extent continues in lower-division college courses) to the more creative engagement with mathematics that is required for upper-division math courses.

- Students will continue the development of the mathematical skills of trying examples, looking for patterns, and making/testing/modifying conjectures.
- Students will continue the development of the mathematical skills of explaining their reasoning to others, and in forming judgments regarding whether an explanation is adequate or not.
- Students will continue the development of the skill of critically reading an account of mathematics.
Students will be able to speak the language of set theory and mathematical logic at a basic level, and will be able to discuss the main constructions and paradoxes.

Class discussions and in-class worksheets, weekly writings, lab “write-ups”, and a final portfolio will provide students with opportunities to demonstrate the level of their abilities relative to the above learning outcomes.

**Organization of the course:** Each week there are two class sessions. The Monday session will focus on “Discussion” (usually from a reading) and the Wednesday session will focus on “Exercises”.

**Discussion Session (Monday):**
There will be an assigned reading (usually posted on Canvas), and at the beginning of class you will have to hand in a short piece of writing based on the text. Give some examples of the concepts you learned, list any questions that occurred to you, and also give any general thoughts you had about the reading. Usually one or two paragraphs is sufficient for this.

During this session we will discuss the reading, and perhaps work on an in-class activity surrounding a chosen math problem. This activity will lead to some questions that you will think about and explore a bit on your own before the next session.

**Exercise Session (Wednesday):**
This session will focus on how you explored, as your homework, the problems introduced in the last session. What did you try? What did you find? Did you make any conjectures? Did you find any explanations? Sometimes you might have to hand in a page or two of handwritten notes describing what you did, or showing some work. We will also spend time on in-class worksheets that expand on the ideas that you thought about for your homework.

**Attendance:** Attendance is very important in this course. I will take attendance during each class, and this will contribute to your final point count in the course.

**Assessment:** Points for this course are awarded according to the following scheme:

- **Attendance** 30 (1.5 points per class session)
- **Weekly writing** 20 (two points per week)
- **Portfolio Drafts** 24 (eight points each)
- **Final Portfolio** 26

This course is offered as P/N only, with 80 points out of 100 being a passing grade. Work must be handed in on time, and must be in a reasonable state of completion. Mistakes can always be corrected later in the course. In this course, the only time you will be penalized for “being wrong” is on the final portfolio.

**Due dates:**
• Weekly writing is due every Monday, at the beginning of class.
• Portfolio drafts are due October 11, November 1, and November 22. The October 11 draft must contain at least one “write-up”, the November 1 draft must contain at least three “write-ups”, and the November 22 draft must contain at least four “write-ups”. (Note that the work is cumulative, so that the November 1 draft only involves two additional write-ups beyond what was already handed in on October 1).

The Portfolios will (mostly) be written in LaTeX, which is the main software used for mathematical typesetting. We will learn how to use this software as the course progresses.

NOTE: Late work is not accepted except in extreme circumstances as determined by the instructor.

Workload: A student should expect to spend 60 hours on this course during the term, with the work divided up roughly as follows:

- Class sessions: 2 hours per week
- Reading: 1 hour per week
- Homework: 3 hours per week.

The “Homework” portion of the workload includes three things: weekly writings on the readings, thinking about the exercises, and five “write-ups” that address topics from our exercise sessions. For the latter, you will choose five of the worksheets we worked on during the quarter and you will give a complete write-up of the solutions. These write-ups should explain the problem, things you tried, any conjectures that arose, and explanations for the conjectures that you know how to resolve. In most cases this will just be a page or two per write-up.

Throughout the course you will maintain a portfolio of your work. The portfolio will contain the things you handed in each week, together with the five write-ups. After getting feedback on your work, you might choose to revise some of it before submitting your final portfolio at the end of the course. This will give you the opportunity to correct mistakes and learn from them, before getting your final grade.

Learning Environment: The University of Oregon strives for inclusive learning environments. Please notify me if the instruction or design of this course results in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 360 Oregon Hall at 541-346-1155 or uoaec@uoregon.edu.

Academic Conduct: The code of student conduct and community standards is at dos.uoregon.edu/conduct. In this course, it is appropriate to help each other on homework as long as the work you are submitting is your own and you understand it.