Math 218: Elementary Number Theory

Spring 2017

Basic Course Information

Instructor: Prof. Jen Paulhus
Time and Location: MWF 3:00- 3:50 PM in 2245 Noyce Science Center
Office Hours: M: 10-11AM, T: 1:30-3PM, W: 11AM-12PM, F:10:30-11:30AM
Office: 2519 Noyce Science Center
e-mail: paulhus@math.grinnell.edu
webpage: `http://www.math.grinnell.edu/~paulhusj/teaching/ma218s17.html`
Mentor: Jun Taek Lee (leejunta@grinnell.edu)
Text:*Explorations in Number Theory*, Jeanne Agnew
The book is available on Pweb under "Library Resources" and "Library E-Reserves Files"
Material Covered: We will cover most of the first four units, and then parts of the other units.
Other Sources: On reserve in the Kistle Science Library:

How to Think Like a Mathematician by Kevin Houston
Write Your Own Proofs in Set Theory and Discrete Math by Amy Babich and Laura Person
An Introduction to the Theory of Numbers by Niven, Zuckerman, and Montgomery
There are also several Combinatorics books available.

What is Number Theory?

Number theory is one of the oldest branches of mathematics, far older than Calculus. The subject, at its most basic, asks questions about the integers. For instance, how are the prime numbers distributed among the integers? What are integer solutions to a particular polynomial equation? Which integers can be expressed as the sum of two squares? The tools used to solve these problems span topics in much of modern pure mathematics.

Learning Goals

The primary goal of this class is to prepare you for the 300 level courses and beyond. We will use number theory as a backdrop to discuss how to think about mathematics, how to read mathematical writings, and how to write good mathematics.

By the end of this course, you should have a much better sense of what advanced mathematics entails. Even if your life goals do not involve further mathematical study, many of the skills you will learn translate to other fields.

As this course is a prerequisite for higher level computer science courses, we will also cover material in preparation for those courses.

Here is what a successful student will master in this class.

- Develop individualized study skills in preparation for the Foundation courses by devising personalized strategies to:
  - get the most out of class time,
  - best utilize time spent on homework,
  - prepare for exams at this level, and
  - successfully internalize deep material.
- Strengthen writing and communication skills in mathematics to the point where the writing clearly articulates the key ideas to non-experts.
- Hone problem solving skills: learn how to approach problems in a new field and how to attack different types of problems.
- Learn key concepts of number theory: divisibility, congruences, Euler ϕ-function, quadratic residues, and multiplicative functions.
- Learn general mathematical concepts: induction, basic counting, binomial coefficients, and equivalence relations.

Growth toward these goals will be measured in class by the students ability to

- solve new, never before seen, problems during exams,
- solve increasingly difficult homework problems,
- write clear solutions to homework problems which may be understood by peers, and
- know definitions, basic computational techniques, and fundamental examples in the subject.

Grading Policies

Homework: Homework assignments will be due *at the beginning* of class approximately every other class period. Assignments are listed on PWeb. No late homework will be accepted but I drop your lowest homework score. However, if you LaTeX your assignment (and you are in class that day), you may submit the assignment before 7 PM on PWeb without being considered late. The grading rubric for homework is posted on PWeb and includes expectations for assignments. Early in the semester some re-writes on homework solutions will be assigned. Homework is 25% of your grade.

Exams: There will be three in-class exams on **February 20**, **March 17**, and **April 28**. The exams are closed books, closed notes, etc. No makeup exams will be given unless agreed to beforehand. Contact me immediately if you have a conflict with an exam. The three exams are 15% each.

Final: There will be a cumulative final which will count for 25% of your grade. The final exam is **Friday, May 17** from 9:00 AM - 12:00 PM. Do not make plans to go home early.

Participation: From time to time during the semester we will have discussions about a variety of topics concerning how to be a mathematician. Additionally, there will be a couple of articles assigned for you to read. We will discuss these articles in class. Finally, you will write a couple of brief personal reflections. Your contributions to these conversations and your writings will count as 5% of your grade.

MASSS The department has a student seminar series which runs many Tuesdays at 11 AM. I will give bonus credit up to $\frac{1}{4}$ of a point on your final grade if you attend at least 3 of these talks and, for each one, send me a paragraph by 5 PM on the Friday immediately following it describing what the talk was about and a new mathematical concept you learned from the talk.

Solutions for the homeworks and grades will be posted on the course's PWeb page.

Other Class Policies

Your final grade in this course will reflect your performance throughout the whole semester. Except for a possible bonus question on the exams and some rewrite opportunities, there will be no extra credit and you cannot retake an exam nor redo homework.

Cell phone usage is strictly prohibited during class. I typically do not allow laptops or tablets in class, but if you would like to take notes on such a device, come talk to me.

Please show up on time, please do not leave in the middle of class unless it is an emergency, and please keep conversations among yourselves during class to an absolute minimum.

Grinnell College makes reasonable accommodations for students with documented disabilities. Students need to provide documentation to the Coordinator for Disability Resources, Autumn Wilke, located on the 3rd floor of the Rosenfield Center (x3702) and discuss your needs with her. Students should then speak with me as early as possible in the semester so we can discuss ways to ensure your full participation in the course, and coordinate your accommodations.

Academic Honesty
Make sure you are familiar with the college's guidelines for academic honesty which you can find here: `http://catalog.grinnell.edu/content.php?catoid=12&navoid=2537#Honesty_in_Academic_Work`
My policies and guidelines may be found on the homework rubric. There are very serious consequences if you are found to be in violation of one of these policies. A typical first offense is a zero on the particular assignment, your final grade in the course is dropped a full letter grade, and you are ineligible to receive honors from any department.

Workload
The time students spend on this course outside of class varies depending on many factors. As this is a core course in our major, 8-10 hours beyond class is quite typical.

Success In My Classes

Students come to this class with very different backgrounds, skills, and experiences. Usually the most successful students in my class have two things in common: they work hard and effectively, and they are able to self-reflect honestly and then make adjustments to their behaviors accordingly.

Mentor

The mentor for Math 218, Jun Taek Lee, is an upper level math major who has already taken some 300 level math courses, including the two foundations courses. His job is to be a guide for students as they transition to proof based mathematics courses, including discussing his own experiences transitioning to 300 level courses. He will also be available to talk about proofs from class, as well as discuss alternative proofs to, and provide supplemental information about, material in class. Jun Taek can help with homework and your writeups, particularly by pointing out where a completed solution goes wrong, or where a written solution gets hard to follow.

Jun Taek will have a rotating schedule which will be posted and updated on PWeb.

Unsolicited Advice

One major goal of the class is to teach you how to think about the problems and explain your solutions like a mathematician. Like any new subject, this requires learning the language we use and the conventions for explaining our work. The best way to do this is to practice, practice, practice.

Read ahead in the material. A list of pages to read before each class will be regularly updated on PWeb.

Most of you will be challenged during the semester. Be prepared to not "get" everything right away.

If you are struggling, come see me early. If you wait until a week before the final, there isn't much that can be done to help you.