

# Syllabus for MATH 278: Number Theory Spring Semester 2015

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Office Hours: M 1:30-3:30pm, W 2:00-4:00pm, F 10:30am-Noon, and by appointment

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Class: held TTh 1:30pm-2:55pm in Napier 202

Textbook: *Number Theory Through Inquiry*,

by David C. Marshall, Edward Odell and Michael Starbird

Website: [http://math.hws.edu/eking/Number Theory/math278.html](http://math.hws.edu/eking/Number%20Theory/math278.html)

*“Mathematics is the queen of the sciences, but number theory is the queen of mathematics.”*

–Carl Friedrich Gauss (1777-1855)

## Course Content and Organization

Natural numbers in particular and integers in general are the mathematical objects to which we are first and most extensively exposed. Number theory is the study of the structure and properties of these numbers. Are there applications of number theory? Certainly cryptography has been a growing field and is something that affects our lives everyday when we make purchases with a credit card, manage a bank account online, and so on. But this area of number theory has only been researched in depth for 40 or so years and number theory has been around for several thousand years. Number theory is the purest of mathematics and mathematicians are drawn to its beauty and its simplicity. Most conjectures are relatively simple to state and understand. Some have been solved quickly, some have taken centuries to solve, and some remain unsolved today. The relationships between integers is a rich and endless playground for study, leading to fascinating results. You may find it addictive! We will delve into number theory by exploring the topics such as divisibility, prime numbers, congruences and cryptography.

You may have already noticed that the textbook is in a different style than many of your classes. There are few proofs or examples worked out for you. The course will be taught using a method called Guided Discovery. There will be discussions, daily student presentations and small group work. Very little time will be spent in lecture. Some of you experienced a modified version of this in First Steps, and here we hope to build on this experience to form an even richer approach to mathematics. Although we will learn many interesting concepts and fascinating facts, the approach to learning them is even more valuable than the concepts and facts themselves. We will strive to help you become a more independent and creative thinker with the courage and passion to explore the unknown. As the authors say, “Attitudes far outlast facts.” And your attitude toward learning can affect your whole approach to life.

## Prerequisites and Goals

First Steps into Advanced Mathematics and Linear Algebra are prerequisites for this class. You are expected to understand the basic proof techniques covered in First Steps and to be able to apply them. Although you will not need any of the individual facts from Linear Algebra, it is expected that you will have refined your proof-writing skills and mathematical ability in that course.

There are two main goals of the course. The first is to explore deeply an area of mathematics you have been aware of for most of your life, and hopefully awaken a curiosity to explore its beauty. The second goal is to guide you on your path to becoming a more sophisticated mathematician. We will work to hone your proof-writing skills and build your mathematical creativity.

## Assessment

*Readings Assignments:* After each class I will assign reading from the text which will include exercises to complete, questions to answer and theorems to prove. I may also assign extra practice problems from other sources. These assignments (as well as collected assignments, notebook problems and announcements) will be listed on our website. You should read with a pencil and paper in hand, experimenting with examples and taking notes as you go, in addition to working the exercises, questions and proofs. Although it is not required, it is recommended that you keep a notebook with notes and solutions from the readings, a vocabulary list and your work on the practice problems.

*Quizzes:* I will give an announced quiz roughly every three or four classes. These will be short and ask you to be able to explain definitions, give examples, or know the statements of theorems. Thus it will be very valuable for you to take notes and keep a vocabulary list from your readings. **Under no circumstances may a quiz be made up.** If you are too sick to take a quiz, we can discuss an alternate assignment.

*Presentations:* Much of the class will consist of students presenting their solutions from the reading assignments to each other. Much of the time I will call on students to go to the board to present, and other times I will rely on volunteers to make presentations. Presentations should be at least as well prepared as written work. If you are well prepared but you make an error you cannot correct at the board, you will get a second chance **without penalty** during the next class period. You will be responsible for doing your portion of these presentations.

When you are observing a presentation, it is your responsibility to follow the logic of the solution and verify that it is correct for yourself. You may be asked during class to re-explain an argument that you just heard. If you cannot follow the reasoning, it is your responsibility to ask a question of the student presenting.

*Seminars:* In addition to regular class time, you will be required to attend two mathematics/computer science seminar talks during the semester, at least one of which must be on mathematics. Seminars usually begin between 3pm and 5pm and last an hour (the days vary). You should be present and attentive for the entire talk. Try to ask a question during the talk or one-on-one with the presenter after the talk. One of the key abilities a mathematician needs is to be able to ask questions in a thoughtful way.

*Attendance:* As this is a two hundred level course, you should be here because you are interested in and dedicated to learning about mathematics. The full nuances of the subject will only be understood if you are fully dedicated to the class. In addition, this course is about participating in the discovery of mathematics (class discussion, groupwork, presentations, etc.), not just learning the facts. Thus, *attendance in class is required*. **More than two unexcused absences will lower your grade by at least one letter. Four or more unexcused absences will result in an automatic failure in the course.** Talk to me in advance if you must miss class for some reason beyond your control. Also, common courtesy demands that you be on time for class, do not leave the room during class (unless you are ill), and turn off and stow your cell phones before class begins. This will help you, your classmates and me focus on what we all came here to learn.

Your attendance, participation, presentations, seminar attendance and quizzes will make up 16% of your grade.

*Collected Homework:* Roughly once a week you will turn in a written assignment (due Mondays at 4pm or before). Usually these assignments will be posted on Wednesdays before office hours. Collected homework should be done neatly; it is recommended that you complete a rough draft first. Submissions with words, etc. crossed out are not acceptable. Neat work shows dedication, will be easier for me to follow and award proper credit, and easier for you to follow when you are reviewing for the exams. Although you may discuss homework problems together, your write-up must be entirely your own. Thus you are encouraged to discuss main ideas and give each other hints, but you may not share complete solutions, and you should make a concerted effort on your own first before speaking with others. The point value for each assignment will vary. Assignments will be considered late if they are not turned in by 4pm on the date they are due. You may turn in one late assignment (up to 42 hours) without penalty.

*Notebook Problems:* One or two problems each week will be designated as “notebook problems”. Notebook problems will generally be proofs or more complex computations. Each proof will be assigned two grades – one for content and one for form. The content grade will reflect the extent to which the appropriate ideas are expressed in your write-up; that is, whether you understood the mathematical ideas required for the proof, and justified and explained this understanding well through appropriate proof methods. The grade for form will take into consideration clarity of expression, completeness, proper usage of both English and mathematical grammar, and whether you really said what you meant to say. Notebook problems may be resubmitted up to two times within one month of the original due date, but not after Tuesday, May 5th at 5pm. The goal is for the final draft of these proofs to be the caliber of those written in a good, detailed textbook. When resubmitting, be sure to include the previous versions of your work. Please turn in notebook problems on a separate sheet of paper than the other problems. Note that the expectations for the quality of your write-up will rise with each resubmission, though you will not be penalized for resubmitting your work and grades of previous versions will be erased. Resubmitting your work does not automatically mean your grade will increase. In fact, if your resubmission introduces errors, your grade may go down. However, this is uncommon and should **NOT** deter you from resubmitting your work. **Notebook problems must be entirely your own work. You may consult me, but may not talk with anyone else. Treat them like a take-home exam.** Note that how actively you work to improve with your resubmissions will influence your participation grade.

*Bonus:* You may earn five bonus points for each additional mathematics/computer science seminar talk you attend (up to fifteen points). You may also earn ten bonus points for turning in at least half of your homeworks typed in  $\text{\LaTeX}$ . I would be happy to give you a short tutorial to introduce you to this process. These bonus points will contribute to your homework grade.

Your collected homework and notebook problems will make up 30% of your grade.

*Project:* During the second half of the semester you will be working on a project with a partner in the class. This will involve writing a five-ten page paper, and presenting your work to the class. The presentations will occur the last week or so of classes. Details about this project will be discussed in March. The project will be worth 10% of your grade.

*Exams:* There will be two **Sunday** midterm exams. The first will take place Sunday, March 1st from 4:00PM until 6:00PM. The second midterm will be Sunday, April 14th from 4:00pm until 6:00pm. Each midterm will be worth 12% of your course grade. The final exam will be Sunday, May 10th from 7:00pm until 10:00pm. The final will be worth 20% of your course grade. It is impossible to construct fair makeup exams in mathematics. Thus, for your protection, my policy is that there are **no** makeup exams. **You must be present for all exams.**

## Disclaimer

The above exam dates, quantity of graded work, policies, and course layout are subject to change in the event of extenuating circumstances.

## The Center for Teaching and Learning (CTL)

At Hobart and William Smith Colleges, we encourage you to learn collaboratively and to seek the resources that will enable you to succeed. The Center for Teaching and Learning (CTL) is one of those resources: CTL programs and staff help you engage with your learning, accomplish the tasks before you, enhance your thinking and skills, and empower you to do your best. Resources at CTL are many: Study Mentors help you find your time and manage your responsibilities, Writing Fellows help you think well on paper, and professional staff help you assess academic needs. I encourage you to explore these and other CTL resources designed to inspire your very best work. You can talk with me about these resources, visit the CTL office on the 2nd floor of the library to discuss options with the staff, or visit the CTL website at <http://www.hws.edu/academics/ctl/index.aspx>.

If you are a student with a “disability” (or what I like to call a “nontraditional approach to learning”) for which you may need accommodations, you should self-identify and register for services with the Coordinator of Disability Services at the CTL, and provide documentation of your disability. Disability-related accommodations and services will not be provided until the registration and documentation process is complete. The guidelines for documenting disabilities can be found at the following website: [http://www.hws.edu/academics/ctl/disability\\_services.aspx](http://www.hws.edu/academics/ctl/disability_services.aspx). Please direct questions about this process, or Disability Services at HWS, to David Silver, Coordinator of Disability Services, at [silver@hws.edu](mailto:silver@hws.edu) or x3351.

## Academic Integrity

I highly encourage you to form a small group with whom you can discuss reading and collaborative assignments. Verbalizing your questions, explaining your mathematical ideas and listening to others will increase your understanding. However, you should **not** feel free to copy someone else’s work or make your work available to someone else. **Copying constitutes plagiarism, a violation of academic integrity which could result in failure in the course. There is, of course, no collaboration or use of outside resources (including other textbooks and the internet) allowed on notebook problems, quizzes or exams.** Violation of the Colleges’ Principle of Academic Integrity will likely result in a report sent to your file in the dean’s office and/or appearance before the Committee on Standards.

## How to Succeed

- Attend all classes on time.
- Remain seated and attentive during all lectures, presentations and whole class discussions.
- Begin working on all assignments **as soon as they are assigned**. Really! Do it!
- Explore and experiment with examples even if not specifically asked to do so in the reading assignments.
- Spend some time **each day** working on the material from this class by yourself.
- Be prepared to present proofs and solutions every class.
- Actively participate in class discussions.
- Find one to three classmates with whom you can discuss the material outside of class.
- Ask your classmates and me lots of questions.
- Listen carefully to other students' ideas.
- Use my office hours liberally.
- Have fun!

## First Collected Homework

Write a one-to-two page typed autobiography (it must be at least one full page). Include your major(s) and minor(s) and the reason you chose to take this course. Describe a mathematical course project you found particularly interesting and why. If you have not had the opportunity to do a mathematical course project yet, describe a mathematical topic you have encountered that particularly intrigued you and why. In addition, describe what are you coming into the course expecting. Also tell me something else interesting about yourself (for example, you might have some interesting plans for the summer... if not, talk to me!). The paper is due Thursday, January 22nd in class, when you will sign up for a short meeting with me in my office. This will help me get to know those of you I do not, and catch up with those of you I do. This assignment is worth 15 points.