MTH 382: Number Theory - Spring 2018

Department of Mathematics, University of Rhode Island

Instructor:	Dr. Michael Barrus
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Office Hours:	TWTh 2:00 – 2:50 pm and/or by appointment
Class Days/Time:	TTh 9:30 – 10:45 am
Classroom:	204 Lippitt Hall
Prerequisites:	MTH 141 or permission of instructor

Course Description

Some of the arithmetic properties of the integers including number theoretic functions, congruences, diophantine equations, quadratic residues, and classically important problems. – *2017-2018 URI Undergraduate & Graduate Catalog*

Course Goals

The main goals of the course, not necessarily in order of importance, are (1) to encourage students to appreciate the beauty of patterns found in the integers, (2) to give you background enabling you to appreciate some of the applications of number theory in life (such as in cryptography, etc.), and (3) to use number theory as a context in which to further develop mathematical maturity and skill.

Student Learning Outcomes

Throughout the semester, a list of desired outcomes for student learning will be updated with current material and available in Sakai, on the "Class Materials" page.

Required Text

Elementary Number Theory by W. Edwin Clark, revised by Michael D. Barrus. Due to the age and copyright status of the book, modifications have been and may occasionally continue to be made to the text. The current version of the text will be made freely available in PDF form through the class Sakai site.

Calculators and other materials

It is recommended that you have a handheld calculator for help on quizzes and exams. Only a calculator will be allowed on these occasions; you may **not** use an app on a tablet, phone, etc. on quizzes or exams. (You may use whatever calculating resources you would like on the homework, though submitted homework must follow the grading guidelines outlined below.) You should not need advanced computing power on quizzes or exams; learning the *steps* of the computation is an important part of the course.

On the other hand, computational tools are a valuable tool for exploring patterns, which is a key part of learning and discovery in number theory, so it is hoped that you will, outside of class, make use of whatever computational tools you have access to (eg. Mathematica, Wolfram Alpha, CoCalc, GeoGebra, programming languages, etc.) to create your own examples and explore your own “tangents” to what we discuss in class. Such tools are also heavily encouraged for use on course projects.

Classroom Protocol

Participation during class will be vital to the learning process, as classroom activities will be designed to provide needed practice and clarify misconceptions. This practice will include daily quizzes and classwork that will be worth 10% of your grade (a more detailed description will be given below); please plan to be in every class, and arrange for help from one or more classmates if you need to miss class.

Students are responsible for being familiar with and adhering to the published "Community Standards of Behavior: University Policies and Regulations” which can be accessed in the University Student Handbook. As with most university courses, all class participants are expected to behave in a respectful and safe manner at all times throughout the semester. Please do your best not to inhibit the learning experience of anyone else, and please feel free to bring any issues you have with others’ behavior to the attention of the instructor. Issues that may arise will be dealt with in as respectful and confidential a manner as possible.

Grading Policy

Grades will be determined through a weighted average with categories and weights as follows:

20% Homework assignments
15% Daily quizzes and classwork
30% Midterm exams (2, equally weighted)

15% Project/presentation
20% Final exam

Each grade category's components and policies will be described in sections that follow. No extra credit is anticipated for this course.

Letter grades for the course will be determined by considering your overall weighted percentage according to the following scale:

A course percentage of at least	guarantees a letter grade of at least	A course percentage of at least	guarantees a letter grade of at least
93	A	77	C+
90	A-	73	C
87	B+	70	C-
83	B	67	D+
80	B-	60	D

A course percentage of less than 60% merits a grade of F.

Homework assignments

Homework will be assigned roughly once a week (though deadlines may vary), for a total of roughly 11 assignments. Assignments may vary in content and format, depending on the current needs of the class.

Deadlines

Unless otherwise specified, for full credit each assignment must be received on its due date, either turned in to me, the math office front desk, or under my office door by the end of our class period on that day (or by whatever alternate time has been announced).

Late homework

In developing mathematical maturity, one of the goals of the course, ***there is no substitute for experience***. In our course, this experience is built through, and measured by, your correct completion of the assigned homework. This is an important part of the course that will not be overlooked when I evaluate your performance in the class. As such, please commit to completing every assigned problem on every homework assignment.

Late homework may be accepted up until 10 class days (i.e., calendar days on which the university is in session) after it is due, though the maximum possible percentage that may be earned will drop in increments of 10 percentage points for each university class day between the original deadline and the submission. For example, an assignment due Thursday that is turned in the

following Tuesday will be graded normally but will have its score capped at 70%. (To minimize points lost, you are encouraged to turn late assignments in as soon as possible, even if it is not a class day. Again, you may email me a scan/photo/digital copy of your assignments, bring them to my office—slipping them under my door, if necessary—or leave them at the Mathematics Department office suite in 200 Lippitt Hall.) Please respect the homework deadlines and policies and expect that I will strictly enforce them.

What the homework should contain

As you are probably aware, computers and calculators are very capable of quickly and painlessly many of the problems our textbook contains. The focus of the homework is ***not*** only for you to discover the numerical values that give the correct answers. Instead, the homework is a chance for you to focus on the ***concepts*** behind the algorithms you will be performing. In light of this view, your homework answers should ***not*** consist solely of numerical answers. Instead, you should **give a fairly detailed explanation of your work, referring to theorems you are using and showing as much work as your textbook's examples typically do**. It is the ***write-up***, and often not the final answer, that will receive the most attention when a problem is graded. I will typically choose and grade between up to 3 questions from each assignment in depth and assign a completion grade to the other problems. Occasionally an assignment may be graded solely on completion, so to gain the full benefit from an assignment you should monitor your own correctness of answers as you go along (check your work in another way; we will discuss how to do this) and ask questions as they arise.

Group work

Group work can be a wonderful thing, and I encourage it. However, do not simply copy someone else's work verbatim or submit work that you do not understand; I consider this dishonest, and it is rarely beneficial to anyone's learning. Please seek help early (from me, a classmate, etc.), and when you do receive help from someone besides yourself, be sure to clearly acknowledge that help with a statement on your homework.

Collaborating with another person or resource is not allowed on any quiz or exam.

Post-assignment review

My goal is to make your homework as helpful of an educational experience as possible, and I am more than happy to review your graded work after it is passed back to you. Any requests for regrading (on either homework, quizzes, or exams) must be brought to my attention within 2 weeks of the item's return in class.

Daily quizzes

Each class period will begin with a short quiz and/or writing prompt over material discussed during the previous class period. For quizzes, on a provided quarter- or half-sheet of paper, and without the use of notes, you will answer two questions. These questions will come from a list of 2-4 questions provided in Sakai at the end of the previous class; the first quiz question will be exactly the same as one of the Sakai questions, and the second quiz question will be closely based on one of the other provided questions, though the format and/or numbers may be changed.

It is hoped that (since the questions will be given to you ahead of time), the quizzes will be an easy way to reinforce concepts and encourage you to keep up with the class (while giving us some early feedback if you need some clarification). Quiz questions can also be good indicators of what you may expect on an exam. Please see me soon if you have any questions in preparing for or reviewing the quizzes, or if you are concerned about your performance on them.

Missed quizzes may not be made up, except in cases of illness or university-excused absences, in which case alternative arrangements will be discussed on a case-by-case basis. Please note that **punctuality in arriving at class will be important, since quizzes will be given at the beginning**, and missed quizzes may not be made up. The lowest four (4) quiz scores will be dropped when computing your grade at the end of the semester.

Midterm exams

There will be two midterm exams, given in class on the following dates:

(1) Thursday, February 22;

(2) Tuesday, April 3.

Both exams will be held in our classroom during our usual class period. Each will be worth 15% of your course grade. While the primary focus the second midterm will be on material covered since the first midterm, you are expected to retain important information from material tested on the earlier exam. More specific information will be given for each exam as it approaches.

Project/presentation

Throughout the semester, you will prepare an in-depth project involving number theory, which you will present (though an in-class presentation, poster, video, or other acceptable medium) during the last week of class.

More specific information, including deadlines, suitable project topics, acceptable presentation methods, and time slots to choose from, will be given throughout the semester.

Final exam

The final exam will be based primarily on material covered since the latter midterm exam, though up to half of the final exam's points may be based on previous material. Unless otherwise suggested by the instructor and agreed upon unanimously by the class, the exam will be offered in our classroom on **Tuesday, May 8, from 8:00 to 11:00 am**. University policies concerning the final exam will be strictly adhered to. More information on the final will be given towards the end of the semester.

Accommodations for special needs

Section 504 of the Rehabilitation act of 1973 and the Americans with Disabilities Act of 1990 require the University of Rhode Island to provide academic adjustments or the accommodations for students with documented disabilities. The student with a disability shall be responsible for self-identification to the Disability Services for Students in the Office of Student Life, providing appropriate documentation of disability, requesting accommodation in a timely manner, and follow-through regarding accommodations requested. It is the student's responsibility to make arrangements for any special needs and the instructor's responsibility to accommodate them with the assistance of the Office of Disability Services for Students.

Any student with a documented disability is welcome to contact me as early in the semester as possible so that we may arrange reasonable accommodations. As part of this process, please be in touch with the Disability Services for Students Office at 330 Memorial Union, 401-874-2098, **http://www.uri.edu/disability/dss/**.

Academic honesty

All submitted work must be your own. If you consult other sources (including resources belonging to other students from this or other universities/semesters and/or online resources such as so-called "homework help" sites) these MUST be properly documented, or you will be charged with plagiarism/academic dishonesty and will receive a penalty for the assignment, up to and including a full loss of credit. In some cases, this may result in a failure of the course as well. In addition, the charge of academic dishonesty will be reported to the URI's Office of Student Life. If you have any doubt about what constitutes plagiarism, visit the URI Student Handbook and University Manual sections on Plagiarism and Cheating at http://www.uri.edu/facsen/8.20-8.27.html.

For example, academic dishonesty includes (but is not limited to) the following actions:

• Using material, directly or paraphrasing, from published sources (print or electronic) without appropriate citation

• Claiming disproportionate credit for work not done independently

• Unauthorized possession or access to exams

• Unauthorized communication during exams

• Unauthorized use of another's work or preparing work for another student

• Taking an exam for another student

• Altering or attempting to alter grades

• The use of notes or electronic devices to gain an unauthorized advantage during exams

• Fabricating or falsifying facts, data or references

• Facilitating or aiding another's academic dishonesty

• Submitting the same paper for more than one course without prior approval from the instructors.

If you are unsure about whether an action you have taken or are considering is academically honest, ***please ask*** (sooner, rather than later).

Additionally, all communication with the instructor must be strictly truthful. Avoid dishonesty for the purpose of receiving points or special arrangements that are not merited by your work or circumstances; the same penalties described above will apply to the assignments, quizzes, and/or exams affected. If you feel pressure to be untruthful because of your circumstances, please contact me early so we can work together to see what options might legitimately be available to you.

Inappropriate use of course materials

All course materials (e.g., outlines, handouts, syllabi, exams, quizzes, slideshows/presentations, lectures, audio and video recordings, etc., whether in tangible or digital form) are copyrighted and subject to licensing. In order to preserve the value of course materials and the educational experiences of later students, and to maintain appropriate copyright status for instructor creations, students are prohibited from posting online or selling any such course materials without express written permission from the instructor, granted in advance.

Religious holidays

It is the policy of the University of Rhode Island to accord students, on an individual basis, the opportunity to observe their traditional religious holidays. Students desiring to observe a holiday of special importance must provide written notification to each instructor; please provide all notifications and discuss any necessary accommodations well in advance of the holiday.

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Tentative Course Schedule

The following schedule is subject to change with fair notice to be given in class and through Sakai.

Week	Date	Topics, Readings, Assignments
1	Jan. 23, 25	Course introduction; Why study number theory? Chapters 1-2: Basic Axioms for **Z**, Proof by Induction
2	Jan. 30, Feb. 1	Chapter 2, continued Chapter 3: Elementary Divisibility Properties
3	Feb. 6, 8	*(Sun 2/5: Open add deadline)* Chapters 4-5: The Floor/Ceiling, The Division Algorithm Chapter 6: The Base *b* Representation of *n*
4	Feb. 13, 15	*(Mon 2/13: Deadline to drop with no transcript entry)* Chapters 7-8: The GCD, The Euclidean Algorithm Chapter 9: Bezout's Lemma
5	Feb. 20, 22	Chapter 10: Blankinship's Method **Thursday, February 22: Exam 1**
6	Feb. 27, March 1	Chapter 11: Prime Numbers Chapter 12: Unique Factorization
7	March 6, 8	*(Mon 3/6: Deadline to drop with transcript entry)* Chapters 13-15: Fermat, Mersenne; Functions; Perfect Numbers Chapter 16: Congruences
8	March 20, 22	Chapter 19: More Properties of Congruences Chapter 20: Residue Classes
9	March 27, 29	Chapter 21: $\mathbf{Z}_m$ and Complete Residue Systems Chapter 22: Addition and Multiplication in $\mathbf{Z}_m$.
10	April 3, 5	**Tuesday, April 3: Exam 2** Chapter 23: The Groups U_m
11	April 10, 12	Chapter 24: Two Theorems of Euler and Fermat Chapter 25-26: Probabilistic Primality, Computation of a^N mod m
12	April 17, 19	Chapter 27: The RSA Scheme Sums of squares and other polygonal numbers
13	April 24, 26	Class projects
Final Exam		**Lippitt Hall Room 204 (our classroom)** **Tuesday, May 8, 8:00 am – 11:00 am**