

Math 312: Introduction to Number Theory

Lecture 1

Lior Silberman¹

¹lior@math.ubc.ca; <http://www.math.ubc.ca/~lior/>
http://www.math.ubc.ca/~lior/teaching/1718/312_S18/

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Numbers ???

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Number
Theory

1 About the
course

2 Learning
methods

3 About me

Number systems

- Natural numbers $\mathbb{N} = \{0, 1, 2, \dots\}$
- Integers (whole numbers) $\mathbb{Z} = \{0, \pm 1, \pm 2, \dots\}$
- Rational numbers $\mathbb{Q} = \left\{ \frac{a}{b} \mid a, b \in \mathbb{Z}, b > 0 \right\}$.
- ...

Types of numbers

- Prime numbers
- Irrational numbers
- Algebraic numbers

Classical “Theory of Numbers”

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- There are infinitely many primes
- The number $\sqrt{2}$ is irrational
- The numbers e, π are transcendental (can't have $\sum_{k=0}^n a_k e^k = 0$ with $a_k \in \mathbb{Z}$ unless all $a_i = 0$).
- Every positive integer is the sum of four squares
($30 = 1^2 + 2^2 + 3^2 + 4^2$)
- Every odd integer ≥ 7 is the sum of three primes
($69 = 17 + 23 + 29$)
- The only integer solutions to $x^p + y^p = z^p$ with $p \geq 3$ have $xyz = 0$.

Applied number theory

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- The largest employer of mathematicians in North America is ...
- Can use number theory to:
 - Establish identity (is `https://www.yourbank.ca` really my bank?)
 - Maintain privacy (can someone read my communications with the bank?)
 - Distribute secrets

Today's Goals

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Learning goals

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- D Basic computational skills (modular arithmetic, cryptography)
Basic notions and basic implications.
- C Definitions, Theorems, direct applications
- B Abstract reasoning
- A Mastery of course material
- A+ General Problem-solving

Course plan

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- The Integers
- Congruences and modular arithmetic
- Arithmetic functions
- Applications to cryptography
- The multiplicative group

Components of the course

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- Classes (TThF 10:00-12:00, W 9:30-10:30 LSK 201)
- Written homework [23%]
 - First problem set due Friday, May 18th
- Online homework [6%]
 - First WebWork due Thursday, May 17th
- Midterm exam June 1 [20%]
- Final exam [50%]
- Two surveys [1%]

How to work

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- Read before class
- Mindful learning in and out of class
- Solve problem rather than review notes
- Come to office hours & use discussion board



Abducted by an alien circus company, Professor Doyle is forced to write calculus equations in centre ring.

(Gary Larson, "The Far Side", 15/9/1992)

About me

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- Dr. Lior Silberman (Li'or Zilberman)
- Email: lior@math.ubc.ca, Office: MATH 229B.
- Work: Number Theory, PDE, Topology, Random Structures, ...

