S-L Number Theory Course Information

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Welcome to the Mathink IOD Senior-Level course! I will be your instructor for the Number Theory portion. This class will cover the number theoretical knowledge assumed by problem writers at competitions like the AMO, as well as giving you tips about how to think in order to maximise your chances of solving problems.

In order to maximise the value you gain from this class, make sure to be an active participant in lectures. This means not only taking notes, but also asking questions if something is unclear and doing your best to answer any questions I ask of the class.

Each handout will also include more problems than we can get to in class. These problems are there for you to attempt both during and after the course as you continue your Olympiad journey.

1 Course Format

The S-L Number Theory course is divided into four terms, each of which is five weeks long. On the first three Sundays of each term I will teach a lecture. The fourth Sunday of each term will be an exam joint with another Mathink course, while on the fifth Sunday I will hold a review and extension session about the term's material. Each week there will also be a student-run discussion session.

Homework is an essential part of this course. At the end of each lecture and review session I will release three homework problems. You should spend at least 15 minutes attempting each homework problem, and then neatly write up any progress or solutions you find. Thus, you should be spending 1–2 hours a week on number theory homework each week it is assigned.

Please submit both neat writeups and rough work for every problem by the discussion session following the lecture. In the discussion session, you should present any solutions you find to the homework.

Homework will be marked on the Google Drive (each problem is out of 7 points) by the following lecture. Please take the time to look at my comments, especially if you think you solved a problem but did not get a 7 for it.

2 Syllabus

Here is an outline of the topics planned for this year.

- Term 1: Induction and Divisibility
  - Lecture 1: Induction and divisibility basics
  - Lecture 2: Division algorithm and applications
  - Lecture 3: Prime factorisations
- Term 2: Modular arithmetic
  - Lecture 4: Basic definitions, existence of inverses
  - Lecture 5: Fermat, Wilson, GCD trick
  - Lecture 6: Euler, CRT, modular contradictions
- Term 3: Diophantine equations
  - Lecture 7: Bounding arguments
  - Lecture 8: Infinite descent, floor functions
  - Lecture 9: Number bases
- Term 4: Other problem types
  - Lecture 10: Constructions and existence proofs
  - Lecture 11: Sequences and integer functions
  - Lecture 12: Integer polynomials