Topics in…

Open Problems in Number Theory

Math 590

Spring 2026

Welcome to Math 590! This course will describe three celebrated open problems in number theory, including two Millennium Prize Problems. These open problems are driving forces behind central research directions in number theory, and this course provides an opportunity for you to understand key ideas.

(I) **The Riemann Hypothesis,** a conjecture about a complex-variable function in number theory that predicts how the precise distribution of prime numbers deviates from their average distribution.

(II) **The Birch—Swinnerton-Dyer Conjecture,** which describes how solutions to cubic equations satisfy a sophisticated local-to-global principle: the number of solutions modulo all primes p collectively determines the number of solutions over the rational numbers.

(III) **The Langlands Functoriality Conjecture,** which asserts the existence of reciprocity laws linking arithmetic, representation theory, analysis, and geometry.

The course is designed to instruct you on foundational material underlying each open problem, prepare you to describe precisely what the problem is, understand what its impact would be if solved, and grasp why it is difficult to solve.

Each module will be comprised of 9 lectures by a lecturer who works in the area of the underlying open problem. During each module, you will complete 2 or 3 problem sets. At the end of the semester, you will write one short essay on a topic chosen from one of the modules, and then discuss your topic (and essay) one-on-one with the relevant lecturer.

Prerequisites: complex analysis (MAT 333), and abstract algebra (MAT 501), and real analysis (MAT 531).

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We hope you will join us for this new course in spring 2026!

Questions about joining the course? Ask us!