Spring 2019 lecture series

Six Mathematical Results with Profound Impact

In this lecture series, we look at six mathematical results that can be stated using no more than high school math yet have profound consequences or impact beyond pure mathematical interests. We will examine the mathematical content and stories behind Pythagorean Theorem, Euler’s Identity, Four-Colour Theorem, Fermat’s Last Theorem, duality theorem for linear programming, and the undecidability of the Halting Problem. We will also explore some of the far-reaching implications which have transformed the way mathematicians view their subject or led to technological advances that we now take for granted. The lectures are aimed at a general audience with a high school math background and an interest in the history of math and technology.

Course outline

The lectures are expected to cover the following points (not necessarily in the order as they appear.)

1. Pythagorean Theorem
   - Pythagoras and the Pythagorean community
   - What the Babylonians knew
   - Proofs by picture
   - Ancient usage
   - Diophantine equations
   - Irrational numbers
   - A modern connection

2. Euler’s Identity
   - The most beautiful theorem in math?
   - A “proof”
   - Imaginary yet true
   - The need for complex numbers
   - Fundamental theorem of algebra
   - An engineer’s toolbox
   - Quaternions and octonions

3. Four-Colour Theorem
   - Turning child’s play into deep math
   - A history of incorrect proofs
– An abstraction that is now all around us
– Do we really have a proof?
– What is a proof?

4. Fermat’s Last Theorem
– The margin is too small for Fermat
– Proof of a special case
– Thousands of false proofs
– Advances in algebraic geometry
– A proof that few could understand
– Mostly as easy as ABC

5. Duality theorem for linear programming
– What is mathematical programming?
– Military connection
– How greedy can you get?
– Nobel Prize-worthy
– Pushing the frontiers of the travelling salesman

6. Undecidability of the Halting Problem
– What is an algorithm?
– Failed attempts
– Hilbert’s program
– Alan Turing’s contribution
– Birth of the theory of computing
– A million-dollar question
– von Neumann architecture
– Beyond classical computers