

# MATH 6010: Computability Theory

MWF 11:30-12:20, on Zoom (login information on Canvas)

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**Course description:** Computability theory is a part of mathematical logic and of computer science. Informally it is the study of what can be calculated by a modern computer. Historically the question of computability actually goes back to before the existence of computers. For example, in 1900 David Hilbert asked for an algorithm that decides whether a given polynomial with integer coefficients has a root in the integers. He probably would have been surprised that in 1970 Yuri Matiyasevich showed that no such algorithm exists, that is, Hilbert's Tenth Problem is not solvable.

In this course we study the basics of computability theory and give some applications following this outline:

- (1) Finite automata, Turing machines, Lambda calculus (models of computation and language recognition)
- (2) Partial recursive functions, recursively enumerable sets
- (3) Halting problem, unsolvable problems in algebra (word problem)
- (4) Oracles and relativization (Turing degrees, jump operator)
- (5) Arithmetical hierarchy
- (6) Post's problem and the finite injury priority method
- (7) Computational complexity (time and space)

**Assignments.** Each week I will post homework problems on the course website. Please submit solutions as pdf on Canvas the following Monday midnight. The final grade is based on these assignments.

**Texts.** The following are some suggested references:

- Hopcroft, Motwani, Ullman. Introduction to automata theory, languages, and computation. Pearson; 3rd edition, 2006.
- Odifreddi. Classical recursion theory. North-Holland Publishing Co., Amsterdam, 1989.
- Papadimitriou. Computational complexity. Addison-Wesley, 1994.
- Sipser. Introduction to the theory of computation. Thomson Course Technology, Boston, 2nd edition, 2006.
- Soare. Recursively enumerable sets and degrees. Springer-Verlag, Berlin, 1987.

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## SPRING PAUSE

The week of March 22-26 will be used in this class as a “spring pause”. During this week, there will be classes but no any assignments due.