

New Course Proposal

Course Number: CS??

Course Title: Computational Complexity II

Per-week-structure Lectures 3 hours, Credits 3*3=9.

Duration Full Semester

Proposing-Department: CSE

Other-Departments/IDPs (which may be interested in the proposed course): None

Other-faculty (interested in teaching the proposed course): None.

Proposing-Instructor: Anil Seth

Credits: 3-0-0-9 (Equivalent to 2.5 hrs of lectures/week)

Background & Course-Objective: Course CS640 gives an introduction to computational complexity. There are many topics of general interest in computational complexity which can't be covered in this course due to limited time. We do have separate specialized courses on many of these topics. This course is intended for someone who wishes to get an introduction to most of these topics in one course.

Syllabus:

- Boolean Circuits: Families of ckts as model of computation. Polynomial size ckts aka class $P/Poly$. TMs with advice and $P/Poly$. $P \subseteq P/Poly$. Consequences of $NP \subseteq P/Poly$. Uniformly generated families. Classes AC and NC , relation to parallel complexity. Exponential size (uniform) ckts and PH .
- Cryptography: secure communication, one way functions and pseudorandom generators. zero knowledge proofs. Hardness amplification basics.
- Lower bounds on concrete computational models:
Decision trees. Switching lemma, AC^0 lower bound for parity, monotone ckts, resolution lower bounds for PHP. Communication complexity approaches to lower bounds.

- PCP and hardness of approximation: Proof of $NP \subseteq PCP(poly, 1)$ and applications.
- Counting Classes: Counting the number of solutions, #P, Toda's theorem.

Depending on availability of time, another topic such as derandomization may be covered.

Prerequisites: CS340 for UG students. No prerequisite for PG students.

References:

1. S. Arora and B. Barak: Computational Complexity, A modern approach. Cambridge Univ Press, 2009. (**Textbook**)
2. I. Wegner: Complexity Theory. Springer Verlag, 2005.

Dated: _____ **Proposer:** _____

Dated: _____ **DUGC/DPGC Convener:** _____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated: _____