

MAY

02

Wednesday

## MODERN COMPLEXITY THEORY

4.8.2020

2018

Week 18  
122-243

9 TAUGHT BY

10 • prof. girish varma

11

### COURSE TOPICS

12

1. intro and proofs

1

• structure of proofs

2

• logical quantifiers

3

• countable & uncountable infinities

4

• cantor's theorem

5

• some basic algorithms

6

• karatsuba's multiplication

7

• euclid's GCD

• proof of correctness & complexity

• axiomatic definitions & impossibility results.

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2018

Week 18

123-242

4.8.2020

2

MAY

Thursday

03

## 2. circuits

- representations of numbers and objects in binary
- prefix free encodings
- circuit computation model
- encoding circuits in binary
- Counting circuits & size hierarchy theorems
- proof of all functions can be computed by circuits
- universality of NAND

## 3. Turing machines

- non-uniform vs uniform computation
- TM definition and examples
- robustness of TM models
- universal TMs
- halting problem and computability

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04

Friday

4.8.2020  
3 2018  
Week 18  
124-241

• turing completeness & church-turing hypothesis

• time, and space hierarchy of TMs

4. NP hardness

• decision vs search problems

• definitions of P, NP, CoNP in terms of proof verification

• reductions

• NP hardness

• NP completeness

• Cook-Levin theorem

5. randomized computation

• recall tail bounds (Markov, Chebyshev, Chernoff)

• definitions of RP, CoRP, BPP

• amplification lemma

• PIT

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2018

Week 18  
125-240

4.8.2020  
4 MAY

Saturday

05

• schwartz zippel lemma and applications.

• adelman's theorem

• average case model

• yao's min-max principle

6. computational learning theory

• sample complexity & PAC learning model

• lower bounds in sample complexity.

• agnostic learning

• hardness of learning

7. quantum computation:

• qubits

• unitary operations

• quantum measurements

• entangled states

Sunday 06

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07

Monday

4.8.2020  
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2018

Week 19

127-238

- quantum circuits
- BQP complexity class
- Simon's algorithm
- Shor's factoring

Other possible topics:

- communication complexity
- complexity of counting
- computational game theory
- interactive computation
- probabilistically checkable proofs

## TEXT BOOKS

1. introduction to the theory of computation; sipser.
2. introduction to theoretical computer science; barak.
3. computational complexity: a modern approach; barak.

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