CMPSC 464 *Intro to Theory of Computation* Sofya Raskhodnikova
Pennsylvania State University April 30, 2016

Preparation for the Final Exam

When: Tuesday, May 3, 2016, 2:30-4:20PM . Please show up a few minutes early so that you can take advantage of the full time available.

Where: 022 DEIKE.

Crib sheets: The exam is *closed book*. You may, however, bring **three** *handwritten* crib sheets on an $8\frac{1}{2} \times 11$ or A4 *colored* sheet of paper. The color of the paper has to be significantly different from white. Preparing a crib sheet can be a useful study aid, so take time in selecting material for it. You may use both sides of the paper and write as small as you like. Calculators and programmable devices are not allowed for this exam.

Where to seat during the exam: Seat two seats apart from your neighbors. If that's not possible, then at least one seat apart. Please do not seat next to your collaborators and friends. If you tend to ask lots of question, try to seat in a location that's easily accessible without disturbing others.

Material covered: You are responsible for all material covered in the lectures, chapters 0-2.3, 3.1-6.1, 7, 8.1-8.3, 9.1 of the book, and homework 0–12. The course home pages has a record of the material covered in lectures.

The final exam will be comprehensive, but the emphasis will be on the material covered since exam w. In particular, in addition to reviewing older material, please review the following topics really well:

- Time and space complexity
  - Designing an algorithm for a problem with given time/space requirements (deterministic or nondeterministic).
  - Analyzing the time/space of your algorithm using asymptotic notation. (Review $O, o, \Theta, \Omega, \omega$ notation.)
  - Designing a polynomial time algorithm for a search problem (e.g., finding a satisfying assignment for a 3cnf formula) assuming that P=NP (e.g., you can call a decider for 3SAT in your algorithm).
- Proving that a language A is NP-complete
  - Proving A is in NP.
  - Giving a polynomial time reduction **from** an NP-complete language to A.
- Class PSPACE
  - TQBF is PSPACE-complete.
  - Proving PSPACE-completeness.
- Relationships between TM models: single-tape, multi-tape, nondeterministic

  - with specified time requirements.
  - with specified space requirements.
  - time vs. space requirements of a TM.
- Relationships between classes
  - P, NP, coNP (that is, the complement of NP), PSPACE, EXPTIME, EXPSPACE.
  - TIME($f(n)$), NTIME($f(n)$), SPACE($f(n)$), NSPACE($f(n)$)
  - Savitch's theorem: PSPACE=NPSPACE.
- Be able to apply Space and Time Hierarchy Theorems.

Practicing for the exam: Make sure you know how to solve all homework and recitation problems and exercises, and solved exercises in the book for appropriate chapters. If you need more practice, use other problems in the book. The exam will be in the same format as exams 1 and 2. It will contain some problems with short answers and some problems with longer answers.

Practice Problems for the Final Exam

Problem 1. What is the language of the following TM?

$M=$ "On input w:

1. Obtain, via the recursion theorem, own description $\langle M \rangle$.
2. Run M on w. If M accepts, *reject*.
3. Otherwise, *accept*."

Answer: $L(M) =$

Problem 2. Practice on the following problems from the book: 7.5, **7.9**, 7.18, 7.20, **7.23**, **7.33**, 7.40, 8.4, 8.11, **8.16**, 9.1, 9.2, 9.3, 9.12.