

Guide to Exam 3

Time and Place

Exam 3 will be held in 153 Snell Engineering Building on Monday, December 11, 1:00-3:00 p.m.

The exam is open book: You may use your notes, homeworks, any materials and solutions provided to you, the textbook (Sipser), and any other paper-based references.

This is not a cumulative final exam. It will instead focus on material covered in the last third of the course, since Exam 2. In particular, it will not include questions like those appearing on Exams 1 and 2 or in Homeworks 1-6. Instead, expect to see questions pertaining to material appearing in Homeworks 7-9.

General Things to Know

- Decision problems: decidable and undecidable languages
- Turing-recognizable and non-Turing-recognizable languages, co-Turing-recognizability
- Proofs of undecidability or non-Turing-recognizability using mapping reductions
- Time complexity of deterministic and nondeterministic Turing machines; polynomial vs. exponential time
- The language classes P and NP
- Polytime reductions and NP-completeness

Specific Things You Should Know How to Do

- Design a Turing machine (possibly a nondeterministic one), using an informal high-level description, to do a specified task. This TM may include “calls” to other TMs or simulate their operation.
- Provide an asymptotic time-complexity analysis of a Turing machine, especially to distinguish polynomial running time from super-polynomial (e.g., exponential) running time.

The purpose of designing such a TM and/or to provide such time-complexity analysis may be to:

- Prove closure or non-closure of a specified language class (especially the decidable languages, P, or NP) under a certain operation applied to its languages.
- Prove that a given language is: decidable, in P, or in NP.
- Prove that a given language is: undecidable or NP-complete.

In addition, you should have sufficient domain knowledge of Boolean formulas and graphs to be able to construct simple reductions from the standard NP-complete languages like *SAT*, *3SAT*, *HAMPATH*, *VERTEX-COVER*, *CLIQUE*, etc.

Specific Things That Will Definitely Appear on the Exam

- You will be required to do at least one of the following:
 - Prove that a given language is decidable.
 - Prove that a given language is in P.
 - Prove that a given language is in NP.
- You will be required to:
 - Prove that a given language is undecidable.
- You will be required to:
 - Prove that a given language is NP-complete.

Additional Insights into What to Expect on the Exam

Where a reduction is required:

- You may be given
 - the language to reduce it from; and/or
 - a description of the actual function that performs the reduction; or
 - some other hint to guide you in determining the appropriate reduction.
- The reduction will be fairly simple and it should be straightforward to prove it has the correct properties (assuming you understand what these properties are).