

# Guide to Exam 2

## Time and Place

Exam 2 will be held in class on Tuesday, November 7, 2006. The exam is open book: You may use your notes, homeworks, any handouts and solutions distributed to you, the textbook (Sipser), and any other paper-based references.

## General Things to Know

- Context-free grammars, leftmost derivations, parse trees, ambiguity
- Pushdown automata and Turing machines: state transition diagrams and informal descriptions
- Multi-tape and/or nondeterministic Turing machines: informal descriptions
- Context-free languages, decidable languages, Turing-recognizable languages
- Closure (and non-closure) properties of context-free, decidable, and Turing-recognizable languages:
  - CFLs closed under union, concatenation, star, and intersection with a regular language; not closed under complement and intersection
  - decidable languages closed under complement, intersection, union, concatenation, and star
  - Turing-recognizable languages closed under union, intersection, concatenation, and star; not closed under complement
- Equivalence of context-free languages, context-free grammars, and PDAs
- That any regular language is context-free
- Pumping Lemma for CFLs
- Turing machines: deciders vs. recognizers
- Decidable languages vs. Turing-recognizable languages

## Specific Things You Should Know How to Do

- Given a CFG and a string, be able to create a derivation and/or a parse tree for that string.
- Given an NFA, be able to create a corresponding PDA.
- Given a description of a language (e.g., in English, as a set, or in the form of a regular expression), be able to construct
  - a CFG that generates it
  - a PDA that recognizes it
  - a TM that decides it
- Given a DFA, be able to create a corresponding TM.
- Be able to apply the Pumping Lemma for CFLs to prove a language is not context-free.
- Be able to apply the closure properties of context-free languages to prove a language is or is not context-free.

In addition you should understand the basic idea behind the proof of the Pumping Lemma for context-free languages: that a parse tree for a sufficiently long string must be tall enough to have a path guaranteed to contain repeated variables.