CMPS 132 Midterm review sheet, W'06

The material from the midterm will cover chapters 3, 4, and sections 5.1 (except for the section on reductions via computation histories) and 5.3 as well as things emphasized in lecture.

The topics include:

1. Decision problems and Languages
2. Turing Machines, transition tables, transition diagrams, configurations, accepting languages, deciding languages, Church-Turing thesis.
3. Combining Turing Machines and standard subroutines (insert, delete, copy, concatenate, addition, etc.).
4. Variations on Turing Machines (examples: Multiple tapes, Two way tape, A finite tape)
5. Non-deterministic Turing Machines and how to "simulate" them with deterministic Turing Machines.
6. TMs can simulate Random Access Machines (RAMs)
7. Universal Turing Machines, encoding letters, strings, and TMs.
8. The Turing recognizable and Turing decidable languages, and their basic definitions (L accepted by TM, TM computes characteristic function for L).
9. The sets of regular languages, context free languages, decidable languages, Turing recognizable languages, and the containments between them. Example languages falling in each class.
10. Enumeration characterizations of the decidable and Turing recognizable languages (and why a language is recursively enumerable if and only if it is Turing recognizable).
11. Turing machine tricks: "Time-splicing" and the "triangle trick"
12. Properties of decidable Languages: closed under union, intersection, complement, concatenation.
13. Properties of Turing recognizable Languages: closed under union, intersection, concatenation
14. if a language and its complement are Turing recognizable, then the language is decidable.
15. Countably infinite versus uncountable sets, the Real numbers are uncountable, the rational numbers are countable.
16. Not all languages Recursively Enumerable – counting arguments and construction by diagonalization.
17. Languages NSA and SA (from lecture) , A_{TM}, and other undecidable languages.
18. Constructive reductions (proofs by contradiction in section 5.1) including tricks for reductions: "brain surgery" on TM's to add pre-processing, post-processing, etc.
19. Mapping reductions (Section 5.3) and their properties.
20. Neither Language EQ_{TM} nor its compliment is Turing recognizable.

Here are some kinds of possible questions:

1. Given a TM figure out what it does (the language accepted or function computed).
2. Construct a TM for solving a simple problem.
3. What is the definition of a term from the above outline? What are simple consequences of the definition?
4. Prove a simple result from the above list (like the closure properties of the decidable or Turing recognizable languages, or the equivalence between enumeration by TM and acceptance by TM, or one of the diagonalization arguments).
5. A problem (or part of a problem) from the homeworks or recommended problems
6. One of the reductions in the text (like showing that A_{TM} reduces to EQ_{TM}).

The exam will have some no-justification-required questions (short answer and multiple guess) as well as a couple of longer questions like those listed above. The exam will have space for your answers, so no blue books required.