Math 166 | You may use one sheet of notes. | 26 May 1999

Name ______________________________ ID No. ______________

There are 125 points tota. (So first exam is 20% and this is 25%.)

1. (45 pts.) Indicate whether true or false. Beware of guessing:

   correct answer +5pts. incorrect answer −3pts. no answer 0pts

   (a) ____ Every finite set of strings is a CFL.

   (b) ____ The language $\{a^n b^n c^n | n > 0\}$ can be recognized by a (1-stack) PDA.

   (c) ____ A PDA with two stacks can recognize more languages than a standard 1-stack PDA.

   (d) ____ If L is Turing-decidable, then $\overline{L}$ is also Turing-decidable.

   (e) ____ A Turing machine with two tapes can recognize more languages than a standard 1-tape Turing machine.

   (f) ____ The language $\{a^n b^n c^n d^n | n > 0\}$ is Turing-recognizable.

   (g) ____ L is Turing-decidable when L is the set of strings of digits that represent primes; that is, $L = \{2, 3, 5, 7, 11, 13, \ldots\}$. ($n$ is a prime if its only positive integer divisors are itself and 1.)

   (h) ____ There exists a Turing machine which can decide if two DFAs are equivalent; that is, whether or not they recognize the same language.

   (i) ____ There exists a Turing machine M which can decide if a Turing machine will loop on a given input; that is, M's input is a description of a machine, say T, and a string, say w, and M accepts the input if T does loop on w and M rejects the input if T does not loop on w.

2. (25 pts.) Prove that, if L and M are CFLs, then so is $L \cup M$.

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3. (30 pts.) Let $L = \{a^n b c^n \mid n \geq 0\}$.
   (a) Construct a context free grammar to generate the language.

   (b) Construct a PDA to recognize the language.

4. (25 pts.) Suppose that both L and $\overline{L}$ are Turing-recognizable. Either (a) prove that L must be Turing-decidable, or (b) give an example of such an L which is not Turing-decidable.

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