

# CSE 531 MIDTERM

November 16, 1993

1. (25%) Carefully and briefly explain why  $\text{NTIME}(T(n)) \subseteq \text{DSPACE}(T(n))$  when  $T(n) \geq n$ .
2. (25%)
  - (a) Carefully define what it means for  $A \leq_m^P B$ .
  - (b) Argue that the relation  $\leq_m^P$  is transitive.
  - (c) Argue that if  $A$  is NP-complete,  $A \leq_m^P B$ , and  $B$  is in NP, then  $B$  is NP-complete.
3. (25%) Let  $L = \{x : L(T_x) \text{ is computable}\}$ . Prove that  $L$  is not recursively enumerable.
4. (25%) Consider the “not everything” problem for regular expressions without star. We call this problem  $\text{NE}(+, \cdot)$ .

Input: A regular expression  $\alpha$  over  $\{0, 1\}$  which just uses union and concatenation (no Kleene star) and an integer  $k$ .

Output: Yes, if  $L(\alpha) \neq \{0, 1\}^k$  and no, otherwise.

Prove that  $\text{CNFSAT} \leq_m^P \text{NE}(+, \cdot)$ . (Hint: Given a CNF formula with  $q$  clauses in  $p$  variables, the corresponding regular expression will be the union of  $q$  relatively simple expressions and the integer  $k$  will be  $p$ .)