

# Theory of Computation

Homework #1

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**Problem 1** Let  $A$  be the set of strings generated by the following context-free language:

$$S \rightarrow (S) \mid SS \mid \epsilon$$

where  $\epsilon$  is the empty string. That is,  $A$  contains the set of all paired parentheses such as  $(( ))$  or  $()(( ))$ . Prove that  $A$  can be decided by a deterministic multi-string Turing machine in log space. (Note: You can just sketch the idea of the machine. No transition function is required here.)

**Problem 2** Let  $B = \{ \langle M \rangle \mid L(M) \text{ is finite} \}$  where  $\langle M \rangle$  is the encoding of machine  $M$  and  $L(M)$  is the language accepted by  $M$ . Show that  $B$  is undecidable.

**Problem 3** Let  $\bar{H}$  be  $\{ M; x \mid M(x) \text{ will not terminate} \}$ . Show that  $\bar{H}$  is not recursively enumerable.

**Problem 4** Let  $L_1$  and  $L_2$  be recursive. Let

$$L_3 = \{ xy \mid x \in L_1 \text{ and } y \in L_2 \}.$$

Show that  $L_3$  is recursive.