

**COMPUTER SCIENCE 3630**  
**Theoretical Foundations of CS**  
**Assignment #3**

Spring 2012

**Due:** Wednesday March 21, 2012 at 11 a.m.

**Late Penalty:** -10% per day late

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**TMs and Pumping**

1. Write a (deterministic) Turing Machine that shifts its input word one cell to the right, *but never moves the head left!* There is a single word of length  $\geq 1$  on the tape which is otherwise blank (use  $B$  for blank). The head is initially on the leftmost character of the word on the input tape. The alphabet consists of  $\{0, 1, B\}$ .
2. Consider the following context free grammar (in Chomsky Normal Form):  
 $G = (\{S, A, B, C\}, \{a, b, c, x\}, S, P)$ , where  $P$  consists of:

$$\begin{array}{lll} S \rightarrow AB & S \rightarrow x & C \rightarrow c \\ A \rightarrow a & B \rightarrow AA & \\ A \rightarrow SA & B \rightarrow BS & \\ A \rightarrow SC & B \rightarrow b & \end{array}$$

Show  $z = xabcbabx \in L(G)$  by giving:

- (a) a derivation tree for  $z$ .
- (b) a leftmost derivation of  $z$ .
- (c)  $|z|$  is sufficiently large for the pumping lemma to hold and hence  $z$  can be decomposed as  $z = uvwxy$ . Show 2 different decompositions of  $z$  and note one of them on the derivation tree.
- (d) Using one of the decompositions in the previous part, use the pumping lemma to produce three more words that are in  $L(G)$ .