

### CS 487 – Assignment 3

Recall  $\mathbf{reverse}(x)$  is the string  $x$  written in reverse order. For example,  $\mathbf{reverse}(01001) = 10010$ . Assume all strings are over the alphabet  $\Sigma = \{0, 1\}$ .

1. Which of the following languages are regular? Prove your answers.
  - (a)  $\{0^{2n} \mid n \geq 1\}$ .
  - (b)  $\{0^m 1^n 0^{m+n} \mid m \geq 1 \text{ and } n \geq 1\}$ .
  - (c)  $\{0^m \mid m \text{ is prime}\}$ .
  - (d)  $\{x \mid x \neq \mathbf{reverse}(x)\}$ .
  - (e) The set of all strings that do not have three consecutive zeros.
  - (f)  $\{xyz \mid |x| > 0, |y| > 0 \text{ and } z = \mathbf{reverse}(x)\}$ .
  - (g)  $\{xyz \mid |x| > 0, |z| > 0 \text{ and } y = \mathbf{reverse}(x)\}$ .
2. Does the language (1d) above fulfill the pumping lemma? Prove your answer.
3. Consider the language of palindromes,  $L = \{x \mid x = \mathbf{reverse}(x)\}$ .
  - (a) Give a context-free grammar for  $L$ .
  - (b) Give a derivation and parse tree for 010010.
  - (c) Convert your grammar to Chomsky normal form.