

**CSci 311 : Models of Computation**  
**CSci 500 : Fundamental Concepts of Computing**  
**Fall Semester 2000, Assignment #2**  
**Due 11:00 A.M., Friday, 8 September 2000**

1. **Assume** the following facts. Let  $\Sigma$  be an alphabet.

- (a) For all strings  $w \in \Sigma^*$ ,  $w\lambda = \lambda w = w$ .  
( $\lambda$  is the identity element for string concatenation.)
- (b) For all strings  $w \in \Sigma^*$ ,  $w^0 = \lambda$ .
- (c) For all strings  $w \in \Sigma^*$  and integers  $n \geq 0$ ,  $w^{n+1} = w^n w$ .
- (d) For all strings  $u \in \Sigma^*$ ,  $v \in \Sigma^*$ , and  $w \in \Sigma^*$ ,  $u(vw) = (uv)w$ .  
(Associativity of concatenation.)
- (e)  $|\lambda| = 0$ .
- (f) For all strings  $w \in \Sigma^*$  and symbols  $a \in \Sigma$ ,  $|wa| = |w| + 1$ .
- (g)  $\lambda^R = \lambda$ .
- (h) For all strings  $w \in \Sigma^*$  and symbols  $a \in \Sigma$ ,  $(wa)^R = aw^R$ .
- (i) Basic properties of integer arithmetic such as associativity and commutativity of addition and multiplication, identity elements for addition (i.e., 0) and multiplication (i.e., 1), and distribution of multiplication over addition.

**Prove**  $(uv)^R = v^R u^R$  for all strings  $u \in \Sigma^*$  and  $v \in \Sigma^*$ . Give justifications for each of your steps (e.g., facts from the above list).

- 2. Exercise 5 on page 27.
- 3. Exercise 8, parts (a) and (c), on page 27.
- 4. Exercise 11, parts (a) and (c), on page 27.
- 5. Exercise 1 on page 33.
- 6. Exercise 2 on page 33.
- 7. **Required for CSci 500 students, optional for CSci 311:**  
Exercise 9 on page 34.