Homework 4: Syntax

This homework is due Friday February 17, 1989 at the beginning of the lecture (1:10 PM). Each weekday that the homework is late you lose 10% of the possible points.

1. (3 points) Describe (in English) the languages denoted by the following regular expressions (where ϵ denotes the empty string.) As an example, 0(0|1)*0, is the language of all strings of binary digits that start and end with a 0 and whose length is at least two.
   (a) ((ϵ|0)1*)*
   (b) (0|1)*0(0|1)*(0|1)
   (c) 0*10*10*10*

2. Write regular grammars for the following languages.
   (a) (1 point) All strings of lowercase letters (from the Roman alphabet) that contain the five vowels (a, e, i, o, and u) in order.
   (b) (3 points) Comments consisting of a string of lowercase letters and the symbols `*` and `/` surrounded by `/*` and `*/` without an intervening `*/`. (Be sure to clearly distinguish between the character `*` and the meta-symbol * used in regular expressions.)

3. This problem concerns the distinction between regular and context-free grammars and languages.
   (a) (2 points) Write a BNF grammar for the language consisting of strings that have n copies of the letter `a` followed by the same number of copies of the letter `b`, where $n > 0$.
   (b) (1 point) Is the grammar in your answer to part (a) above a regular grammar?
   (c) (2 points) Is the language described in part (a) of this question a regular language?

4. (4 points) Do exercise 4-7 on page 164 in the text.

5. (2 points) Do exercise 4-9 on page 167 in the text. (Do not use your answer to the previous question as your answer for this question.)

6. This problem concerns the syntactic description of separators.
   (a) (2 points) Write a BNF description for an ⟨actual parameter list⟩, which is defined as a sequence of one or more ⟨expression⟩s separated by commas.
   (b) (2 points) Write an extended BNF description for a ⟨compound statement⟩, which is defined as a **begin**, followed by one or more ⟨statement⟩s separated by semicolons, followed by an **end**.

7. Consider the following grammar for the Pascal **if** statement.

⟨stmt⟩ ::= ⟨assign⟩ | ⟨if stmt⟩
⟨assign⟩ ::= ⟨id⟩ := ⟨expr⟩
⟨if stmt⟩ ::= **if** ⟨bool expr⟩ **then** ⟨stmt⟩
    | **if** ⟨bool expr⟩ **then** ⟨stmt⟩ **else** ⟨stmt⟩
⟨bool expr⟩ ::= **true**
⟨id⟩ ::= x
⟨expr⟩ ::= 1

(a) (2 points) Prove that this grammar is ambiguous.

(b) (3 points) Write a BNF grammar that describes the same language as the grammar of part a of this problem, but which is not ambiguous.