COMS W4115
Programming Languages and Translators
Homework Assignment 1

Prof. Stephen A. Edwards
Columbia University

Due October 2nd, 2003
at 5:40PM (beginning of class)

Submit solution on paper; do not email it.

Write both your name and your Columbia ID (e.g., se2007) on your solutions.

Do this assignment alone. You may consult the instructor or a TA, but not other students.

1. Using ANTLR or Lex syntax, write an unambiguous grammar or regular expression for each of the following regular languages.

   (a) Nonnegative even binary numbers, e.g., 100 110 10 0

   (b) Nonnegative integer decimal numbers divisible by three. (Hint: sum their digits)

   (c) C's floating point numbers, as defined by Ritchie:

   > A floating constant consists of an integer part, a decimal point, a fraction part, an `e`, and an optionally signed integer exponent. The integer and fraction parts both consist of a sequence of digits. Either the integer part or the fraction part (not both) may be missing; either the decimal point or the `e` and the exponent (not both) may be missing.

2. Draw a DFA for a scanner that recognizes and distinguishes the following set of keywords. Draw accepting states with double lines and label them with the name of the keyword they accept.

   ```
   auto case char const continue default
   do double else enum if ifelse
   ```

3. Dragon book, 3.16, p. 149:

   Construct nondeterministic finite automata for the following regular expressions using Algorithm 3.3 (p. 122, shown in class) and show the sequence of moves made by each while processing the input string *ababbab*.

   (a) $(a\,|\,b)^*$

   (b) $(a^*\,|\,b^*)^*$

   (c) $((\varepsilon\,|\,a)b^*)^*$

   (d) $(a\,|\,b)^*abb(a\,|\,b)^*$

4. Dragon book, 4.23, p. 270:

   (a) Using the grammar

   $$S \rightarrow (L)\,|\,a$$
   $$L \rightarrow L,S\,|\,S$$

   construct a rightmost derivation for $(a,(a,a))$ and show the handle of each right-sentinel form.

   (b) Show the steps of a shift-reduce (bottom-up) parser corresponding to this rightmost derivation.

   (c) Show the steps in the bottom-up construction of a parse tree during this shift-reduce parse.

5. Disambiguate and remove left recursion from the following grammar (i.e., show an equivalent grammar):

   $e \rightarrow e$ `>>` $e\,|\,e$ `?` e `:` $e\,|\,e$ `->` $e\,|\,$**id**

   Use C's precedence rules, i.e., the precedence of `->` is higher than that of `>>` is higher than that of `?:`. All are left-associative.