COP5621 Compiler Construction Exam 1 - Spring 2007

Name: ________________________________ (Please print)

Put the answers on these sheets. Use additional sheets when necessary. You can collect 100 points in total for this exam.

1. Why are "forward declarations" needed in Pascal programs (or similarly, when do we require function prototypes in C)? (**mark one**) (4 points)

   (a) Programmers often make mistakes, so redundant declarations are useful to detect typing errors early.

   (b) Pascal and C are designed for single-pass compilers.

   (c) The compiler makes multiple passes over the input to check all declarations, including forward declarations.

   (d) To make the programming language strongly typed.

2. Which one of the following identities on REs is *correct*? (**mark one**) (4 points)

   (a) $a(a|b|\epsilon) = (aa|ab)$

   (b) $((a|\epsilon)b)^* = (a|b)^*$

   (c) $(a^*b^*)^* = (a|b)^*$

   (d) $ab^* = abb^*$

3. Convert the following *infix* expression to *postfix*. You may assume the standard precedence and associativity of the operators is used. (4 points)

```
(a+b)*c−d/e
```

4. There is a serious problem with the following Lex specification:

```
digit        [0-9]
integer      {digit}{integer}|{digit}
%%
{integer}    { /* do something ... */ }
%%
```

   Rewrite the specification to fix this problem. (8 points)

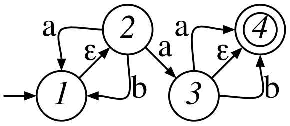
5. Draw and label the runtime data areas of the JVM. (10 points)

6. Consider the following grammar $G = (\{\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}\}, \{S, X\}, P, S)$, with P:

$$\begin{array}{rcl} S & \rightarrow & X\ \mathbf{a} \\ & \mid & X\ \mathbf{b} \\ X & \rightarrow & X\ \mathbf{c} \\ & \mid & \mathbf{d} \end{array}$$

Apply left factoring of the productions for S followed by left-recursion elimination of the productions for X. (10 points)

7. Given the NFA with $Q = \{1, 2, 3, 4\}, \Sigma = \{\mathbf{a}, \mathbf{b}\}, q_0 = 1, F = \{4\}$ and transition graph



   (a) Convert the NFA to a DFA using the algorithm in the book and illustrated in class. Express your answer as a DFA transition graph. Identify the start and final states of the DFA. (10 points)

   (b) Prove that the DFA that you obtained is minimal. (5 points)

8. Consider the RE `a(a|b)*b`.

   (a) Use Thompson's algorithm to construct an NFA for this RE. (10 points)

   (b) Convert the NFA to a DFA. (10 points)

   (c) Minimize the DFA. (10 points)

9. Consider the RE $\mathtt{a}^*\,\mathtt{(a|b)}\,\mathtt{b}^*\;\mathtt{\#}$ augmented with an endmarker #.

   (a) Create the syntax tree of the RE and annotate the tree with *nullable*, *firstpos*, and *lastpos* as defined in the book and illustrated in class. (5 points)

   (b) From the annotated syntax tree, create a table of *followpos*. (5 points)

   (c) Construct the DFA for the regular expression. Identify the start and final states of the DFA. (5 points)