T-106.4200 Introduction to Compiling
Exam Dec. 19 2013

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No written material is allowed in this exam. Submit at least one answer sheet, even if an empty one! Write on *each* answer sheet you submit the code of the course, the date, your name, and your student ID number.

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1. Answer shortly to the following questions:

   (a) What does the letter S in SLR(1) mean?

   (b) To which direction (in parse tree) do attribute values go in an S-attributed grammar?

   (c) What is an LR(0) item?

   (d) What is dead code?

   (e) What is a basic block?

   (f) What kind of type conversions are called coersions?

   (12 p)

2. Consider the following regular expression:

   $$(x \mid y)^*\, x\, (z\, x \mid z^*)$$

   (a) Make an NFA for the regular expression by using *Thompson's construction*. Number states starting from zero.

   (b) Build a DFA from the NFA. Name the states by capital letters starting from A.

   (5+5 p)

3. Consider the following grammar:

   $$A \rightarrow B =\!+\ e \mid B =\!-\ e$$
   $$B \rightarrow A\ [\ e\ ] \mid e$$

   The grammar has five terminal symbols: e, $=+$, $=-$, [and]. It is easy to see that the grammar is (indirectly) left recursive. Modify the grammar to the form suitable for top-down parsing. (7 p)

P.T.O.

4. Consider the following augmented grammar

$$
\begin{aligned}
A' &\rightarrow A \\
A &\rightarrow (B) \mid \mathbf{id} \\
B &\rightarrow B+A \mid B-A \mid \varepsilon
\end{aligned}
$$

(a) Make the collection of LR(0) sets of items and the corresponding state transition function (shown as table) for the grammar. Start numbering of states from zero.

(b) Based on (a), build an SLR(1) parsing table for the grammar. Present also the FOLLOW sets.

(c) Is the grammar an SLR(1) grammar?

(6+6+1 p)

5. Why intermediate languages (intermediate representation) are used in compilers? What are the two most important features that distinct them from the typical programming languages? Why they do have these features? (4 p)

6. Consider the following ambiguous grammar:

$$S \rightarrow \mathtt{a}\ S\ \mathtt{b} \mid S\ \mathtt{x}\ S \mid S\ \mathtt{y} \mid \mathtt{z}$$

For each of the three strings below, Indicate whether the rightmost parse of the string is ambiguous or unambiguous according to this grammar. Show all of the possible rightmost parse trees for that string.

(a) `z x z y`

(b) `z y y`

(c) `a z x z b y x z`

(9 p)