

Computer Science Comprehensive Exam—Spring 2014
Compiler Construction

Instructions: Do *not* put your name on the exam, please answer all the questions directly on the exam itself. You may write on the back of the pages. You may need scratch paper to work out the answers before writing them on the exam. Answer **all** the questions. You have 90 minutes. Explain answers as fully as possible, give examples or define terms, if appropriate.

1. For each statement below, circle either “true” or “false” as appropriate.
 - (a) true / false There exists a regular expression r for which the formal language denoted by r is exactly the set of syntactically correct Java programs.
 - (b) true / false The set of languages recognized by SLR grammars is a proper subset of the languages recognized by context-free grammars.
 - (c) true / false The set of languages recognized by LR(1) grammars is a proper subset of the languages recognized by LL(1) grammars.
 - (d) true / false The set of languages recognized by LALR(1) grammars is a proper subset of the languages recognized by LR(1) grammars.

2. Why are there no possible shift/shift conflicts in an LR parsing table?

- Using the construction of the textbook, convert the regular expression $(a|b)^*abb$ to an NFA. Convert the resulting NFA to a DFA.

4. Consider the following grammar (uppercase letters are nonterminals):

- 1 $S \rightarrow I : L$
- 2 $S \rightarrow I$
- 3 $I \rightarrow \mathbf{id}$
- 4 $I \rightarrow L \mathbf{lb}$
- 5 $L \rightarrow \mathbf{id}$
- 6 $L \rightarrow (\mathbf{lb} : L)$

- (a) Give any string/sentence of length seven in the language generated by the grammar.
- (b) Compute nullable, FIRST and FOLLOW for *each* non-terminal.
- (c) Is the grammar LL(1)? yes / no Explain.
- (d) Define what *left factoring* means.
- (e) Is it possible to left factor the grammar? yes / no If so, give the result. If not, explain.
- (f) Is the result LL(1)? yes / no Explain.

5. Consider the following grammar (uppercase letters are nonterminals):

- 0 $S' \rightarrow S\$$
- 1 $S \rightarrow a A d$
- 2 $S \rightarrow b B d$
- 3 $S \rightarrow a B c$
- 4 $S \rightarrow b A c$
- 5 $A \rightarrow c$
- 6 $B \rightarrow c$

Answer all the following questions on the remainder of the page and on the back. Circle the word “yes” or “no” as appropriate, and don’t forget to explain.

- (a) Give a diagram of the LR(1) states and transitions.
- (b) Give the entire LR(1) parsing tables.
- (c) Is the grammar LR(1)? yes / no Explain.
- (d) Give the entire LALR(1) parsing tables.
- (e) Is the grammar LALR(1)? yes / no Explain.