

# T-106.4200 Introduction to Compiling

## Exam Dec. 14, 2011

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No written material nor electronic devices are 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. There are six problems in this exam.

### 1. Answer shortly to the following questions:

- (a) In compiling, what does static mean?
- (b) What is a lookahead symbol?
- (c) What is an LR(0) item?
- (d) What is bottom-up parsing?
- (e) What does the dollar character mean in parsing?
- (f) What is an R value?
- (g) What is a hole in a scope?
- (h) What is three-address code?

(8 p)

2. (a) Consider an NFA with the following transition table (state 0 is the start state and 16 the only accepting state):

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
$\epsilon$	1,8	2,4		7			7	1,8	9,11		16	12,14		12,14		16	
$a$			3										13				
$b$					5					10							
$c$						6									15		

Construct a DFA from this NFA by using the subset construction method. Name the states by capital letters starting from A.

- (b) A scanner can be based on a DFA or NFA. Give advantages and disadvantages of these two approaches. In which situation would you prefer an NFA? (7+4 p)

3. (a) Write a context-free grammar for the language of strings that consist of a series of zeroes followed by a series of the same number of ones, e.g. 01 and 00001111 belong to that language.
- (b) Write a context-free grammar for the language of strings that consist of an equal number of zeroes and ones, e.g. 1010 and 01001101 belong to that language.
- (c) Write an attribute grammar for the language given in (b). Its underlying context-free grammar should be SLR(1). (3+3+4 p)

P.T.O.

4. Why intermediate languages or other intermediate representations are used in compilers? What are the two most important properties, which make them different from programming languages? Why they have such properties? (6 p)

5. (a) Compute FIRST and FOLLOW sets for the nonterminals of the grammar

$$\begin{aligned} D &\rightarrow HT \\ H &\rightarrow (D) \mid \mathbf{id} \\ T &\rightarrow (L)T \mid [L]T \mid \varepsilon \\ L &\rightarrow DR \\ R &\rightarrow , DR \mid \varepsilon \end{aligned}$$

- (b) Construct an LL(1) parsing table for the grammar.

- (c) Is the grammar LL(1)? (4+7+1 p)

Copy the table below on your answer sheet and fill the empty cells with yes or no answers. No justification is required. Each correct answer brings 0.5 points, but 1 point is reduced for every wrong answer. (Leave a cell empty, if you are not quite sure.) The sum is rounded to an integer.

Grammar	Ambi- guous	LL(1)	SLR(1)
$S \rightarrow aSa \mid aSb \mid c$			
$S \rightarrow SaS \mid bS \mid c$			
$S \rightarrow aSa \mid bS \mid c$			
$S \rightarrow aSa \mid \varepsilon$			
$S \rightarrow Sa \mid b \mid c$			

(8 p)