Computer Science Comprehensive Exam—Fall 2000
Compiler Construction

Instructions: Please answer all the questions directly on the exam itself. Answer **all** the questions. Explain answers as fully as possible, give examples if appropriate, define terms.

1. Give a regular expressions for comments in Ada. Comments in Ada begin with two dashes -- and continue until the end of the line.

2. How are variant records typically allocated at runtime?

3. What is the relationship between the set of languages recognized by LL(1) parsers and the set of languages recognized by LR(1) parser?

4. Consider the following grammar:

$$
\begin{array}{lcl}
S & \rightarrow & u\,B\,D\,z \\
B & \rightarrow & B\,v \\
B & \rightarrow & w \\
D & \rightarrow & E\,F \\
E & \rightarrow & y \\
E & \rightarrow & \epsilon \\
F & \rightarrow & x \\
F & \rightarrow & \epsilon
\end{array}
$$

(a) Compute nullable, *FIRST* and *FOLLOW* for all nonterminals.

	nullable	*FIRST*	*FOLLOW*
S			
B			
D			
E			
F			

(b) Compute the *FIRST* of the right-hand side of all productions.

	α	$FIRST(\alpha)$
1	$S \rightarrow u\,B\,D\,z$	
2	$B \rightarrow B\,v$	
3	$B \rightarrow w$	
4	$D \rightarrow E\,F$	
5	$E \rightarrow y$	
6	$E \rightarrow \epsilon$	
7	$F \rightarrow x$	
8	$F \rightarrow \epsilon$	

(c) Fill in the LL(1) parse table for the grammar. Explain clearly why the grammar is *not* LL(1).

	w	u	v	x	y	z
S						
B						
D						
E						
F						

5. Consider the following grammar and its associated LR(0) parsing table.

1	S'	$\rightarrow$	$S\,\$$
2	S	$\rightarrow$	$(\,L\,)$
3	S	$\rightarrow$	**x**
4	L	$\rightarrow$	S
5	L	$\rightarrow$	$L\,,S$

	action					goto	
state	(	)	**x**	,	$	S	L
1	s3		s2			g4	
2	r3	r3	r3	r3	r3		
3	s3		s2			g7	g5
4					acc		
5		s6		s8			
6	r2	r2	r2	r2	r2		
7	r4	r4	r4	r4	r4		
8	s3		s2			g9	
9	r5	r5	r5	r5	r5		

Show the parsing steps of the string `((x),x)` by completing all the remaining steps in the diagram on the next page.

	stack	input	action
(1)	1	**((x),x)** $	shift 3
(2)	1 **(** 3	**(x),x)** $	shift 3
(3)	1 **(** 3 **(** 3	**x),x)** $	shift 2
(4)	1 **(** 3 **(** 3 **x** 2	**),x)** $	reduce by $S \to \mathbf{x}$
(5)			
(6)			
(7)			
(7)			
(8)			
(9)			
(10)			
(11)			
(12)			
(13)			
(14)			

6. Consider the following augmented grammar.

$$
\begin{array}{rcl}
S' & \rightarrow & S\$ \\
S & \rightarrow & V = E \\
S & \rightarrow & E \\
E & \rightarrow & V \\
V & \rightarrow & \mathbf{x} \\
V & \rightarrow & \mathbf{*}\, E
\end{array}
$$

Begin (do not complete) the LR(1) item set construction for the grammar. What is the initial state? What is the next state, if you choose the transition for the terminal *****?