

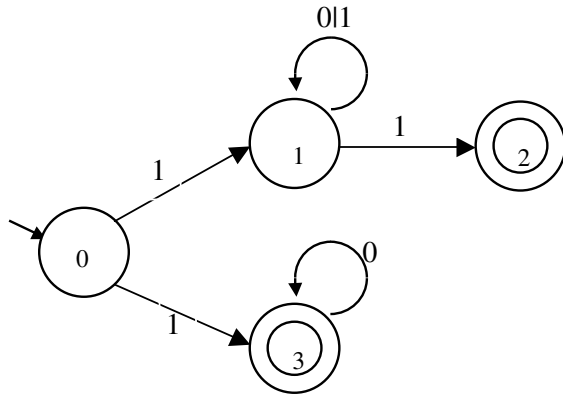
CA448 Compiler Construction 1
End of Year Examination Answers 2007

1. (a) $1(011)^*1 \mid 10^*$

[10 marks]

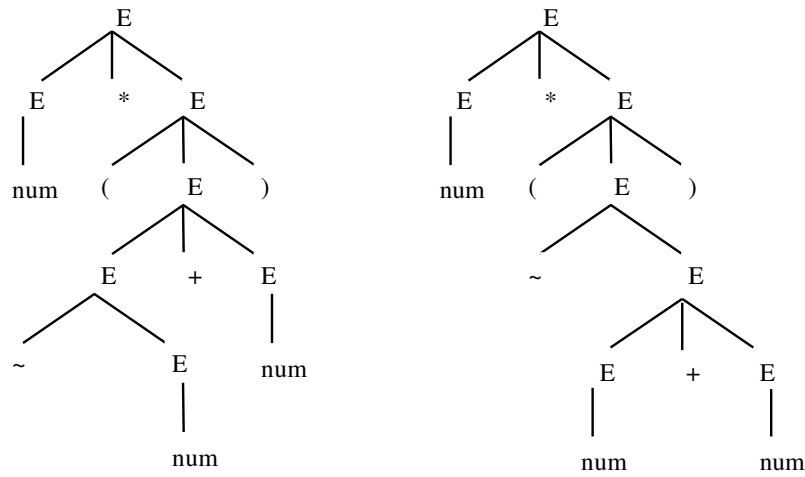
(b)

[10 marks]



3. The following parse trees are produced for the given expression:

[10 marks]



4. The unambiguous grammar is as follows:

[10 marks]

$E \rightarrow T + E \mid T$

$T \rightarrow F * T \mid F$

$F \rightarrow \sim F \mid (E) \mid \text{num}$

$$\begin{aligned}
5. \text{LOOKAHEAD}(S \rightarrow ABa) &= (\text{FIRST}(A) - \{\epsilon\}) \cup (\text{FIRST}(B) - \{\epsilon\}) \cup \{a\} \quad [10 \text{ marks}] \\
&= \{b\} \cup \{a\} = \{a,b\} \\
\text{LOOKAHEAD}(A \rightarrow bA) &= \text{FIRST}(b) \\
&= \{b\} \\
\text{LOOKAHEAD}(A \rightarrow \epsilon) &= (\text{FIRST}(\epsilon) - \{\epsilon\}) \cup \text{FOLLOW}(A) \\
&= \{\} \cup \{a\} = \{a\} \\
\text{LOOKAHEAD}(B \rightarrow aB) &= \text{FIRST}(a) \\
&= \{a\} \\
\text{LOOKAHEAD}(B \rightarrow \epsilon) &= (\text{FIRST}(\epsilon) - \{\epsilon\}) \cup \text{FOLLOW}(B) \\
&= \{\} \cup \{a\} = \{a\}
\end{aligned}$$

The grammar is not LL(1) since a predicts both $B \rightarrow aB$ and $B \rightarrow \epsilon$

6. The following LR(0) items are produced for this grammar: [10 marks]

- 1: $S \rightarrow \bullet E \$$
 $E \rightarrow \bullet T$
 $E \rightarrow \bullet E ; T$
 $T \rightarrow \bullet$
 $T \rightarrow \bullet T a$
- 2: $S \rightarrow E \bullet \$$
 $E \rightarrow E \bullet ; T$
- 3: $S \rightarrow E \$ \bullet$
- 4: $E \rightarrow E ; \bullet T$
 $T \rightarrow \bullet$
 $T \rightarrow \bullet T a$
- 5: $E \rightarrow E ; T \bullet$
 $T \rightarrow T \bullet a$
- 6: $E \rightarrow T \bullet$
 $T \rightarrow T \bullet a$
- 7: $T \rightarrow T a \bullet$

There are shift-reduce conflicts in states 5 and 6, so the grammar is not LR(0).

7. $\text{FOLLOW}(S) = \{\$ \}$ [10 marks]
 $\text{FOLLOW}(E) = \{\$, ; \}$
 $\text{FOLLOW}(T) = \{\$, ;, a \}$

There are no longer any conflicts, so the grammar is SLR(1)

8. The following LR(1) items are produced for this grammar:

[10 marks]

- 1: $S \rightarrow \bullet A, \$$
 $A \rightarrow \bullet, \$$
 $A \rightarrow \bullet bAb, \$$
- 2: $S \rightarrow A\bullet, \$$
- 3: $A \rightarrow b\bullet Ab, \$$
 $A \rightarrow \bullet, b$
 $A \rightarrow \bullet bAb, b$
- 4: $A \rightarrow bA\bullet b, \$$
- 5: $A \rightarrow bAb\bullet, \$$
- 6: $A \rightarrow b\bullet Ab, b$
 $A \rightarrow \bullet, b$
 $A \rightarrow \bullet bAb, b$
- 7: $A \rightarrow bA\bullet b, b$
- 8: $A \rightarrow bAb\bullet, b$

There are shift-reduce conflicts in states 3 and 6 between the last two items in each case, so the grammar is not LR(1).

9. A possible order of evaluation is as follows:

[10 marks]

- E_1 .place
- E_2 .place
- E_3 .place
- E_4 .place
- E_5 .place
- E_5 .value
- E_6 .place
- E_6 .value
- E_4 .value
- E_3 .value
- E_2 .value
- E_1 .value

10. The three-address code is as follows:

[10 marks]

- $t1 := b - d$
- $t2 := t1 * 4$
- $t3 := t2 + a$
- $t4 := t3 * c$
- $t5 := 2 * e$
- $x := t4 / t5$