

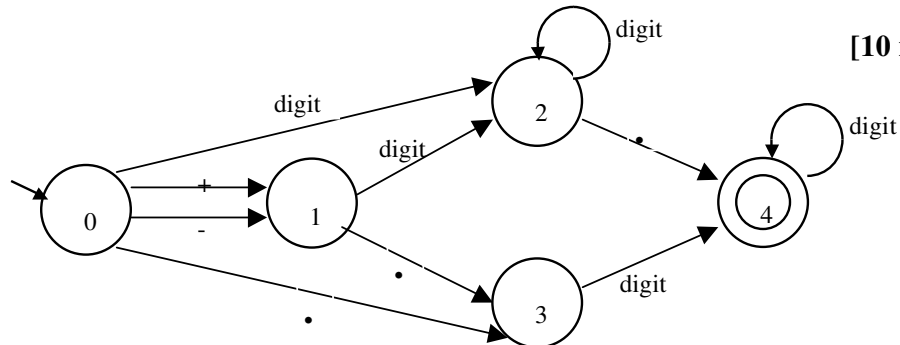
## CA448 Compiler Construction 1 End of Year Examination Answers 2006

1.  $(+|-|\epsilon) \text{digit}^* (\text{digit} \cdot | \cdot \text{digit}) \text{digit}^*$

[10 marks]

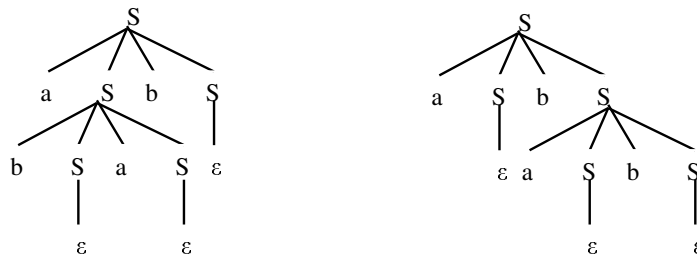
2.

[10 marks]



3. The following parse trees can be derived for the sentence abab:

[10 marks]



Therefore the grammar is ambiguous.

$$4. \text{LOOKAHEAD}(S \rightarrow AB) = (\text{FIRST}(A) - \{\epsilon\}) \cup \text{FIRST}(B) \\ = \{a,b\} \cup \{a\} = \{a,b\}$$

[10 marks]

$$\text{LOOKAHEAD}(A \rightarrow C) = (\text{FIRST}(C) - \{\epsilon\}) \cup \text{FOLLOW}(A) \\ = \{b\} \cup \{a\} = \{a,b\}$$

$$\text{LOOKAHEAD}(A \rightarrow aA) = \text{FIRST}(a) \\ = \{a\}$$

$$\text{LOOKAHEAD}(B \rightarrow a) = \text{FIRST}(a) \\ = \{a\}$$

$$\text{LOOKAHEAD}(C \rightarrow b) = \text{FIRST}(b) \\ = \{b\}$$

$$\text{LOOKAHEAD}(C \rightarrow \epsilon) = (\text{FIRST}(\epsilon) - \{\epsilon\}) \cup \text{FOLLOW}(C) \\ = \{\} \cup \{a\} = \{a\}$$

The grammar is not LL(1) since a predicts both  $A \rightarrow C$  and  $A \rightarrow aA$

5. The converted grammar is as follows:

[10 marks]

$$\begin{aligned} E &\rightarrow T E' \\ E' &\rightarrow + T E' \\ E' &\rightarrow \epsilon \\ T &\rightarrow \text{id } T' \\ T' &\rightarrow ( T'' \\ T' &\rightarrow \epsilon \\ T'' &\rightarrow L) \\ T'' &\rightarrow ) \\ L &\rightarrow E L' \\ L' &\rightarrow ; L \\ L' &\rightarrow \epsilon \end{aligned}$$

6. The following LR(0) items are produced for this grammar:

[10 marks]

$$\begin{aligned} 1: S' &\rightarrow \bullet S\$ \\ S &\rightarrow \bullet xA \\ S &\rightarrow \bullet By \\ B &\rightarrow \bullet xB \\ B &\rightarrow \bullet y \\ 2: S' &\rightarrow S \bullet \$ \\ 3: S' &\rightarrow S \$ \bullet \\ 4: B &\rightarrow y \bullet \\ 5: S &\rightarrow B \bullet y \\ 6: S &\rightarrow B y \bullet \\ 7: S &\rightarrow x \bullet A \\ B &\rightarrow x \bullet B \\ A &\rightarrow \bullet xA \\ A &\rightarrow \bullet y \\ B &\rightarrow \bullet xB \\ B &\rightarrow \bullet y \\ 8: S &\rightarrow xA \bullet \\ 9: B &\rightarrow xB \bullet \\ 10: A &\rightarrow x \bullet A \\ B &\rightarrow x \bullet B \\ A &\rightarrow \bullet xA \\ A &\rightarrow \bullet y \\ B &\rightarrow \bullet xB \\ B &\rightarrow \bullet y \\ 11: A &\rightarrow y \bullet \\ B &\rightarrow y \bullet \\ 12: A &\rightarrow xA \bullet \\ 13: B &\rightarrow xB \bullet \end{aligned}$$

There is a reduce-reduce conflict in state 11, so the grammar is not LR(0).

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

[10 marks]

- 1:  $S \rightarrow \bullet Aa, \$$   
 $S \rightarrow \bullet bAc, \$$   
 $S \rightarrow \bullet Bc, \$$   
 $S \rightarrow \bullet bBa, \$$   
 $A \rightarrow \bullet d, a$   
 $B \rightarrow \bullet d, c$
- 2:  $S \rightarrow A\bullet a, \$$   
3:  $S \rightarrow Aa\bullet, \$$   
4:  $S \rightarrow B\bullet c, \$$   
5:  $S \rightarrow Bc\bullet, \$$   
6:  $A \rightarrow d\bullet, a$   
 $B \rightarrow d\bullet, c$
- 7:  $S \rightarrow b\bullet Ac, \$$   
 $S \rightarrow b\bullet Ba, \$$   
 $A \rightarrow \bullet d, c$   
 $B \rightarrow \bullet d, a$
- 8:  $S \rightarrow bA\bullet c, \$$   
9:  $S \rightarrow bAc\bullet, \$$   
10:  $S \rightarrow bB\bullet a, \$$   
11:  $S \rightarrow bBa\bullet, \$$   
12:  $A \rightarrow d\bullet, c$   
 $B \rightarrow d\bullet, a$

There are no conflicts, so the grammar is LR(1).

8. Merging states 6 and 12 results in a reduce-reduce conflict, so the grammar is not LALR(1).

[10 marks]

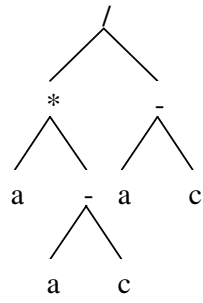
9. The attribute grammar is as follows:

[10 marks]

$E \rightarrow E' + T$	$E.value := E'.value + T.value$
$E \rightarrow E' - T$	$E.value := E'.value - T.value$
$E \rightarrow T$	$E.value := T.value$
$T \rightarrow T' * F$	$T.value := T'.value * F.value$
$T \rightarrow T' / F$	$T.value := T'.value / F.value$
$T \rightarrow F$	$T.value := F.value$
$F \rightarrow int$	$F.value := int$
$F \rightarrow (E)$	$F.value := E.value$

10. The abstract syntax tree is as follows:

[10 marks]



The directed acyclic graph is as follows:

