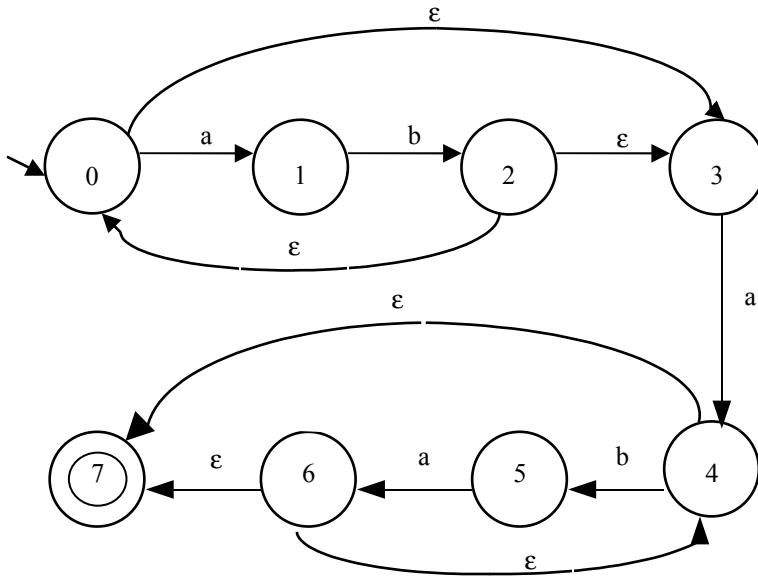


## CA448 Compiler Construction 1 End of Year Examination Answers 2008

1.

[10 marks]



2.

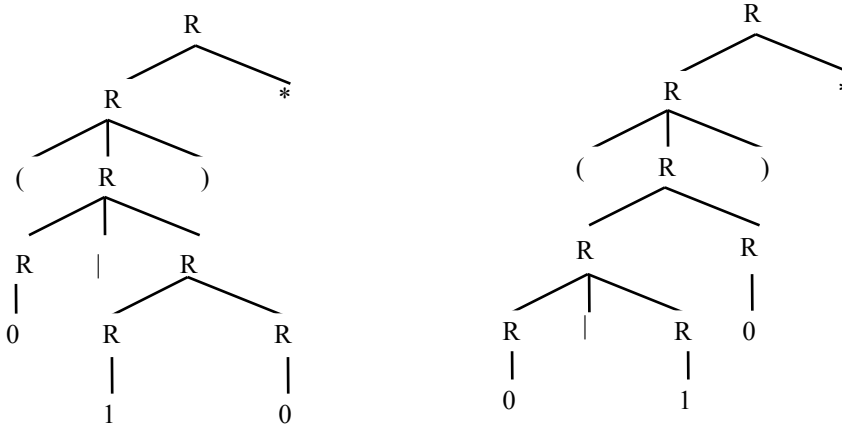
[10 marks]

State	a	b
A = {0,3}	B	C
B = {1,4,7}	D	C
C = {0,2,3,5}		
D = {1,4,6,7}		

The start state is A and the accepting states are B and D.

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

[10 marks]



4. The unambiguous grammar is as follows:

[10 marks]

$$\begin{aligned}R &\rightarrow R \setminus | S | S \\S &\rightarrow S T | T \\T &\rightarrow T^* | (R) | 0 | 1\end{aligned}$$

5.

[10 marks]

$$\begin{aligned}\text{LOOKAHEAD}(S \rightarrow ABC) &= (\text{FIRST}(A) - \{\epsilon\}) \cup (\text{FIRST}(B) - \{\epsilon\}) \cup \text{FIRST}(C) \\&= \{b\} \cup \{a\} \cup \{b\} = \{a,b\} \\ \text{LOOKAHEAD}(A \rightarrow bA) &= \text{FIRST}(b) \\&= \{b\} \\ \text{LOOKAHEAD}(A \rightarrow \epsilon) &= (\text{FIRST}(\epsilon) - \{\epsilon\}) \cup \text{FOLLOW}(A) \\&= \{\} \cup \{a,b\} = \{a,b\} \\ \text{LOOKAHEAD}(B \rightarrow aB) &= \text{FIRST}(a) \\&= \{a\} \\ \text{LOOKAHEAD}(B \rightarrow \epsilon) &= (\text{FIRST}(\epsilon) - \{\epsilon\}) \cup \text{FOLLOW}(B) \\&= \{\} \cup \{b\} = \{b\} \\ \text{LOOKAHEAD}(C \rightarrow b) &= \text{FIRST}(b) = \{b\}\end{aligned}$$

The grammar is not LL(1) since b predicts both  $A \rightarrow bA$  and  $A \rightarrow \epsilon$

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

[10 marks]

- 1:  $S' \rightarrow \bullet S\$$ 
  - $S \rightarrow \bullet Ab$
  - $S \rightarrow \bullet B$
  - $A \rightarrow \bullet aB$
  - $B \rightarrow \bullet a$
  - $B \rightarrow \bullet aA$
- 2:  $S' \rightarrow S \bullet \$$
- 3:  $S' \rightarrow S \$ \bullet$
- 4:  $S \rightarrow A \bullet b$
- 5:  $S \rightarrow Ab \bullet$
- 6:  $S \rightarrow B \bullet$
- 7:  $A \rightarrow a \bullet B$ 
  - $B \rightarrow a \bullet$
  - $B \rightarrow a \bullet A$
  - $B \rightarrow \bullet a$
  - $B \rightarrow \bullet aA$
  - $A \rightarrow \bullet aB$
- 8:  $A \rightarrow aB \bullet$
- 9:  $B \rightarrow aA \bullet$

There is a shift-reduce conflict in state 7, so the grammar is not LR(0).

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

[10 marks]

- 1:  $S \rightarrow \bullet Aa, \$$   
 $S \rightarrow \bullet Bb, \$$   
 $S \rightarrow \bullet cC, \$$   
 $A \rightarrow \bullet D, a$   
 $B \rightarrow \bullet D, b$   
 $D \rightarrow \bullet, a$   
 $D \rightarrow \bullet, b$
- 2:  $S \rightarrow A\bullet a, \$$
- 3:  $S \rightarrow B\bullet b, \$$
- 4:  $S \rightarrow c\bullet C, \$$   
 $C \rightarrow \bullet Ab, \$$   
 $C \rightarrow \bullet Ba, \$$   
 $A \rightarrow \bullet D, b$   
 $B \rightarrow \bullet D, a$   
 $D \rightarrow \bullet, b$   
 $D \rightarrow \bullet, a$
- 5:  $A \rightarrow D\bullet, a$   
 $B \rightarrow D\bullet, b$
- 6:  $S \rightarrow Aa\bullet, \$$
- 7:  $S \rightarrow Bb\bullet, \$$
- 8:  $S \rightarrow cC\bullet, \$$
- 9:  $C \rightarrow A\bullet b, \$$
- 10:  $C \rightarrow B\bullet a, \$$
- 11:  $A \rightarrow D\bullet, b$   
 $B \rightarrow D\bullet, a$
- 12:  $C \rightarrow Ab\bullet, \$$
- 13:  $C \rightarrow Ba\bullet, \$$

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

8. Merging states 5 and 11 results in a reduce-reduce conflict, so the grammar is not LALR(1). [10 marks]

9. The attribute grammar is as follows:

[10 marks]

$E \rightarrow E' \text{ or } T$	$E.value := E'.value \vee T.value$
$E \rightarrow T$	$E.value := T.value$
$T \rightarrow T' \text{ and } F$	$T.value := T'.value \wedge F.value$
$T \rightarrow F$	$T.value := F.value$
$T \rightarrow \text{not } F$	$T.value := \neg F.value$
$F \rightarrow \text{true}$	$F.value := \text{True}$
$F \rightarrow \text{false}$	$F.value := \text{False}$
$F \rightarrow (E)$	$F.value := E.value$

10. The acyclic graph is as follows:

[10 marks]

