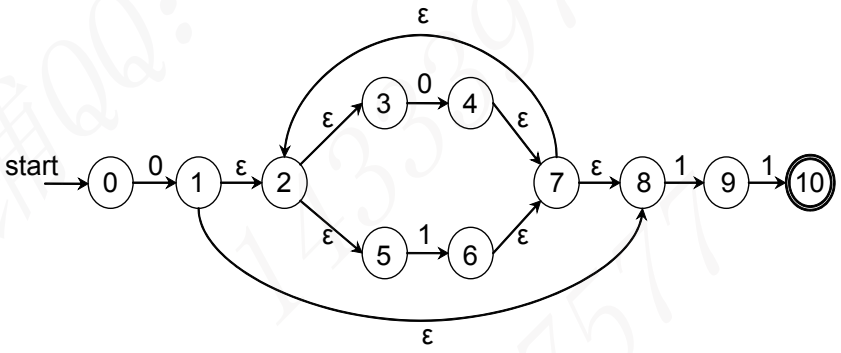
武汉大学计算机学院2005-2006学年第二学期

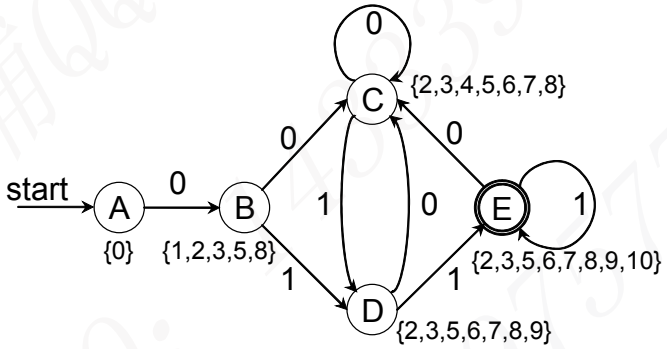
2003级《编译原理》参考答案

一、 (1) 由0和1组成，以0开始并以11结尾的字符串集合

(2)



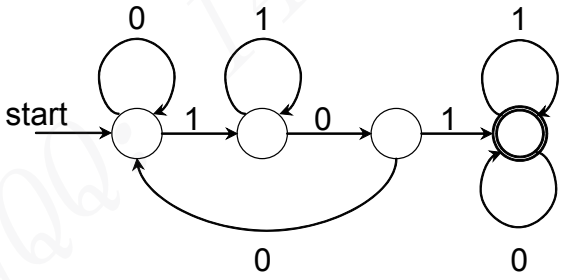
(3)



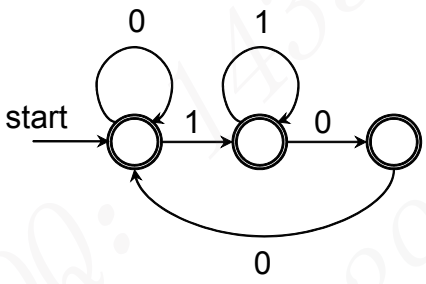
(4) Ⓐ $\xrightarrow{0}$ Ⓑ $\xrightarrow{1}$ Ⓓ $\xrightarrow{1}$ Ⓔ $\xrightarrow{0}$ Ⓒ $\xrightarrow{1}$ Ⓓ $\xrightarrow{1}$ Ⓔ

二、 (1) $r = (0|1)^*101(0|1)^*$;

(2)



(3)



三、 (1) $\text{First}(S) = \{\, a, b, d \,\}$;
$\text{First}(A) = \{\, a, b, c, d \,\}$;
$\text{First}(B) = \{\, a, b, d, \varepsilon \,\}$;
$\text{First}(C) = \{\, a, b, d, \varepsilon \,\}$;

(2) $\text{Follow}(S) = \{\, c, \$ \,\}$;
$\text{Follow}(A) = \{\, a, b, c, d, \$ \,\}$;
$\text{Follow}(B) = \{\, c, d, \$ \,\}$;
$\text{Follow}(C) = \{\, b \,\}$;

(3)

	a	b	c	d	\$
S	$S \to aAB,\ S \to Bd$	$S \to Bd$		$S \to Bd$	
A	$A \to BcA,\ A \to a$	$A \to BcA$	$A \to BcA$	$A \to BcA$	
B	$B \to Cb$	$B \to Cb$	$B \to \varepsilon$	$B \to Cb \mid \varepsilon$	$B \to \varepsilon$
C	$C \to Sc$	$C \to Sc,\ C \to \varepsilon$		$C \to \varepsilon$	

(4) 不是LL(1)文法。

四、 (1)

$$
\begin{aligned}
S &\underset{rm}{\Longrightarrow} AcB \\
&\underset{rm}{\Longrightarrow} AcbcB \\
&\underset{rm}{\Longrightarrow} Acbcb \\
&\underset{rm}{\Longrightarrow} acAcbcb \\
&\underset{rm}{\Longrightarrow} acacbcb
\end{aligned}
$$

(2) 由a、b和c组成的字符串集合，形如：$(ac)^m(bc)^n b$ $(m > 0,\, n \geq 0)$;

(3) 移进第一个a之后所在的状态$\{\, A \to a \bullet cA, A \to a\bullet \,\}$, 由于$c \in \text{Follow}(A)$, 所以面对输入$c$, 在该状态下可以用$A \to a$归约，也可移进$c$到状态$\{\, A \to ac \bullet A \,\}$, 因此有移进/归约冲突，不是SLR(1)文法；

(4)

$$
\begin{aligned}
&S \to AB\\
&A \to acA \,\big|\, ac\\
&B \to bcB \,\big|\, b
\end{aligned}
$$

五、 设有命题公式文法G(S)定义如下： (10分，5+5)

(1)

$$
\begin{aligned}
S &\underset{lm}{\Longrightarrow} S \vee S\\
&\underset{lm}{\Longrightarrow} a \vee S\\
&\underset{lm}{\Longrightarrow} a \vee S \wedge S\\
&\underset{lm}{\Longrightarrow} a \vee a \wedge S\\
&\underset{lm}{\Longrightarrow} a \vee a \wedge a
\end{aligned}
\qquad
\begin{aligned}
S &\underset{lm}{\Longrightarrow} S \wedge S\\
&\underset{lm}{\Longrightarrow} S \vee S \wedge S\\
&\underset{lm}{\Longrightarrow} a \vee S \wedge S\\
&\underset{lm}{\Longrightarrow} a \vee a \wedge S\\
&\underset{lm}{\Longrightarrow} a \vee a \wedge a
\end{aligned}
$$

(2)

$$
\begin{aligned}
&S \to S \vee T \,\big|\, T\\
&T \to T \wedge F \,\big|\, F\\
&F \to \neg F \,\big|\, (S) \,\big|\, a
\end{aligned}
$$

六、 (1) $\mathrm{First}(S) = \{\, a, (, \neg \,\}$;
$\mathrm{Follow}(S) = \{\, \vee, \wedge,), \$ \,\}$;

(2)

$$
\begin{aligned}
I_2 = \big\{\ & S \to (\bullet S),\ S \to \bullet S \vee S,\ S \to \bullet S \wedge S,\\
& S \to \bullet \neg S,\ S \to \bullet (S),\ S \to \bullet a \,\big\}\\
I_7 = \big\{\ & S \to S \vee \bullet S,\ S \to \bullet S \vee S,\ S \to \bullet S \wedge S,\\
& S \to \bullet \neg S,\ S \to \bullet (S),\ S \to \bullet a \,\big\}
\end{aligned}
$$

(3)

state	action							goto
	$\neg$	(	)	$\wedge$	a	$\vee$	\$	S
0	s1	s2	/	/	s9	/	/	11
1	s1	s2	/	/	s9	/	/	10
2	s1	s2	/	/	s9	/	/	3
3	/	/	s4	s5	/	s7	/	/
4	/	/	r4	r4	/	r4	r4	/
5	s1	s2	/	/	s9	/	/	6
6	/	/	r2	r2	/	r2	r2	/
7	s1	s2	/	/	s9	/	/	8
8	/	/	r1	s5	/	r1	r1	/
9	/	/	r5	r5	/	r5	r5	/
10	/	/	r3	r3	/	r3	r3	/
11	/	/	/	s5	/	s7	acc	/

(4)

	stack	input	action
(1)	I_0	$\neg a \vee a \wedge a\$$	shift
(2)	$I_0 \neg I_1$	$a \vee a \wedge a\$$	shift
(3)	$I_0 \neg I_1 a I_9$	$\vee a \wedge a\$$	reduce $S \rightarrow a$
(4)	$I_0 \neg I_1 S I_{10}$	$\vee a \wedge a\$$	reduce $S \rightarrow \neg S$
(5)	$I_0 S I_{11}$	$\vee a \wedge a\$$	shift
(6)	$I_0 S I_{11} \vee I_7$	$a \wedge a\$$	shift
(7)	$I_0 S I_{11} \vee I_7 a I_9$	$\wedge a\$$	reduce $S \rightarrow a$
(8)	$I_0 S I_{11} \vee I_7 S I_8$	$\wedge a\$$	shift
(9)	$I_0 S I_{11} \vee I_7 S I_8 \wedge I_5$	$a\$$	shift
(10)	$I_0 S I_{11} \vee I_7 S I_8 \wedge I_5 a I_9$	$\$$	reduce $S \rightarrow a$
(11)	$I_0 S I_{11} \vee I_7 S I_8 \wedge I_5 S I_6$	$\$$	reduce $S \rightarrow S \wedge S$
(12)	$I_0 S I_{11} \vee I_7 S I_8$	$\$$	reduce $S \rightarrow S \vee S$
(13)	$I_0 S I_{11}$	$\$$	accept

七、 (1)

(1) $S \rightarrow S_1 \vee S_2$ { $S.neg :=$ "(" $+ S_1.neg +$ "$\wedge$" $+ S_2.neg +$ ")" }

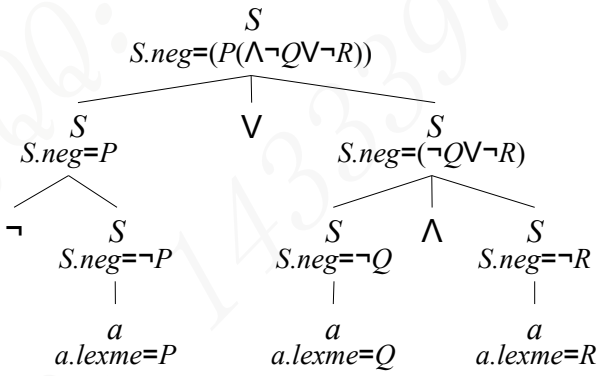
(2) $S \rightarrow S_1 \wedge S_2$ { $S.neg :=$ "(" $+ S_1.neg +$ "$\vee$" $+ S_2.neg +$ ")" }

(3) $S \rightarrow \neg S_1$ { $S.neg :=$ if if_first_is_neg($S_1.neg$) then
delete_first($S_1.neg$)
else
"$\neg$" $+ S_1.neg$ }

(4) $S \rightarrow (S_1)$ { $S.neg := S_1.neg$ }

(5) $S \rightarrow a$ { $S.neg :=$ "$\neg$" $+ a.lexme$ }

(2)



八、 (1) `if (a > b + c) x = b - c + b * c; else x = e / f;`

```
    t0 := b + c              (1)  +     b    c    t1
    if a > t0 goto L1        (2)  if>   a    t0   (7)
    t1 := e / f              (4)  /     e    f    t1
    x := t1                  (5)  :=    t1   /    x
    goto L2                  (6)  jump (11)
L1: t2 := b * c              (7)  *     b    c    t2
    t3 := b - c              (8)  -     b    c    t3
    t4 := t2 + t3            (9)  +     t2   t3   t4
    x := t4                  (10) :=    t4   /    x
L2:                          (11)
```

(2) `do s = s + 1; i++; while (i < 100);`

```
L1: t0 := s + 1              (1)  +     s    1    t0
    s := t0                  (2)  :=    t0   /    s
    t1 := i + 1              (3)  +     i    1    t1
    i := t1                  (4)  :=    t1   /    i
    if i < 100 goto L1       (5)  if<   i    100  (1)
```

九、 设`main()`中的变量`i`的地址为`x`, 则`f()`被调用时运行环境如下：

address	memory	note
	.....	
x	1	←i of main, a+7
x-4	fp	← of main, a+6
x-8	ret add	←of main, a+5
x-16	1	←i of f, a+4
x-24	-1	←a+3
x-28	-1	←a+2
x-32	-1	←a+1
x-36	-1	←a of f
	.....	

利用缓冲区溢出实现对运行环境的修改：当`f()`中的`while (i)`循环执行到`i = 4`时，`a + 4`指向`i`, `*(a + 4)= -1`将修改`i`的值为`-1`, `i++`又将`i`的值修改为`0`, 再次进入循环时, 循环条件不成立, 从而终止循环; `*(a + 7) += 2`将修改`main()`中`i`的值为`1 + 2`, 所以最后的打印结果为`3`。