

## 《编译原理》期末试题试卷(A)参考答案

(考试形式：闭卷 考试时间：2 小时)



《中山大学授予学士学位工作细则》第六条

考试作弊不授予学士学位

方向：\_\_\_\_\_ 姓名：\_\_\_\_\_ 学号：\_\_\_\_\_

注意：答案一定要写在答卷中，写在本试题卷中不给分。本试卷要和答卷一起交回。

1. (8 points) Give a regular expression for each of the following languages over the alphabet  $\{a, b\}$ :

(1) (4 points) All nonempty strings that start and end with the same symbol.

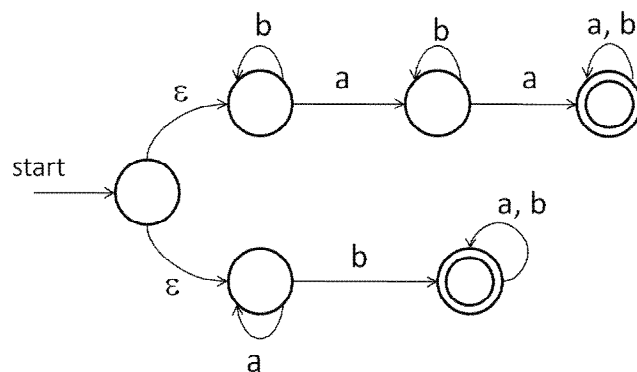
(2) (4 points) All strings that contain no repeated b's (including the empty string).

### 【参考答案】

(1)  $a(a|b)^*a \mid b(a|b)^*b \mid a \mid b$

(2)  $a^*(ba+)^*b?$

2. (12 points) Consider the following NFA:



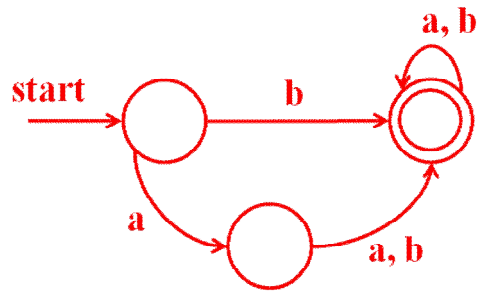
(1) (4 points) What language does the NFA accept? Please describe it in natural language.

(2) (8 points) Convert the NFA to an equivalent DFA. You may construct the DFA directly.

### 【参考答案】

(1) 所有至少包含 2 个 a 或 1 个 b 的由 a, b 组成的字符串.

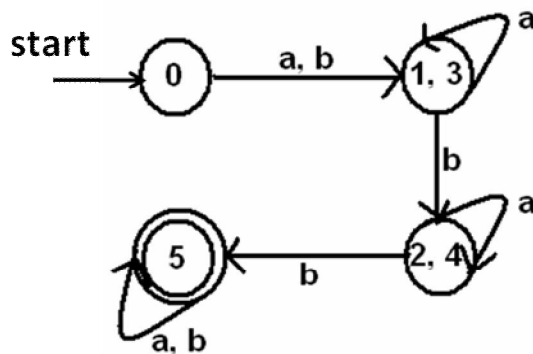
(2)



3. (7 points) Minimize the DFA represented by the following transition table, where state 0 is the start state and state 5 is the only accepting state.

	a	b
0	1	3
1	1	2
2	2	5
3	3	4
4	4	5
5	5	5

【参考答案】



4. (10 points) Give a context-free grammar (CFG) for each of the following languages over the alphabet  $\{a, b\}$ :

- (1) (5 points)  $L = \{a^i b^j \mid i \geq 0 \text{ and } 2 \cdot i \leq j \leq 3 \cdot i\}$ .
- (2) (5 points)  $L = \{w \mid w \text{ contains an odd number of symbols, and the symbol in the middle of } w \text{ is } a\}$ .

【参考答案】

- (1)  $S \rightarrow aSbb \mid aSbbb \mid \epsilon$
- (2)  $S \rightarrow aSa \mid aSb \mid bSa \mid bSb \mid a$

5. (8 points) Consider the following grammar over the alphabet  $\{a, b, c\}$ :

$S \rightarrow Xa$   
 $X \rightarrow bX$   
 $X \rightarrow Y$

$Y \rightarrow Zc$

$Z \rightarrow bZ$

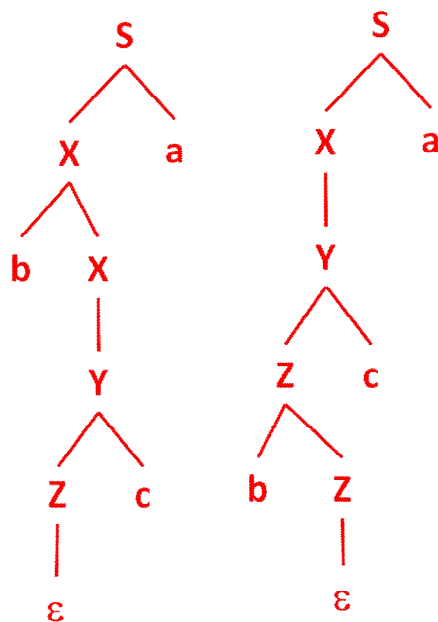
$Z \rightarrow \varepsilon$

(1) (5 points) Demonstrate that this grammar is ambiguous.

(2) (3 points) Please remove exactly one production from this grammar to obtain an unambiguous grammar generating the same language.

【参考答案】

(1)



(2) 删除  $X \rightarrow bX$  或  $Z \rightarrow bZ$  均可.

6. (12 points) Compute FIRST and FOLLOW for each nonterminal in the following grammar:

$S \rightarrow A$

$A \rightarrow BA'$

$A' \rightarrow iBA' \mid \varepsilon$

$B \rightarrow CB'$

$B' \rightarrow +CB' \mid \varepsilon$

$C \rightarrow )A^* \mid ($

【参考答案】

$\text{FIRST}(S) = \text{FIRST}(A) = \text{FIRST}(B) = \text{FIRST}(C) = \{ (, ) \}$

$\text{FIRST}(A') = \{ i, \varepsilon \}$

$\text{FIRST}(B') = \{ +, \varepsilon \}$

$\text{FOLLOW}(S) = \{ \$ \}$

$\text{FOLLOW}(A) = \text{FOLLOW}(A') = \{ \$, * \}$

$\text{FOLLOW}(B) = \text{FOLLOW}(B') = \{ \$, *, i \}$

$\text{FOLLOW}(C) = \{ \$, *, +, i \}$

7. (13 points) Consider the following grammar:

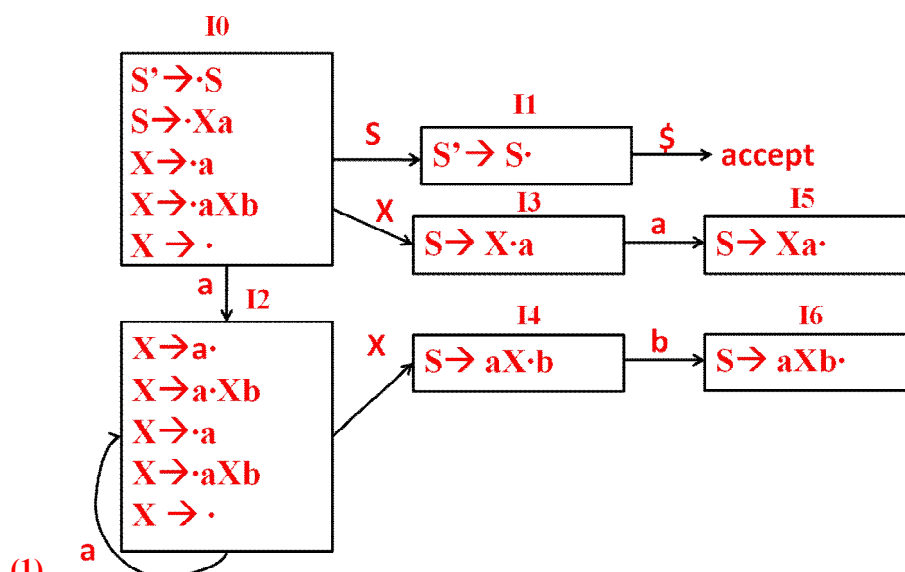
$S \rightarrow Xa$

$X \rightarrow a \mid aXb \mid \varepsilon$

(1) (9 points) Construct a DFA for viable prefixes of this grammar using LR(0) items.

(2) (4 points) Identify a shift-reduce conflict and a reduce-reduce conflict under SLR(1) parsing.

【参考答案】



(1)

(2) 由于  $a \in \text{FOLLOW}(X) = \{a, b\}$ , 因而在状态 I0 (或 I2), 遇到输入符号 a 时既可移进也可归约; 由于  $a \in \text{FOLLOW}(X) = \{a, b\}$ , 因而在状态 I2, 遇到输入符号 a 时既可用产生式  $X \rightarrow a$  归约, 也可用产生式  $X \rightarrow \varepsilon$  归约.

8. (10 points) The following grammar generates binary fractions.

$F \rightarrow 0.B$

$B \rightarrow 0B$

$\mid 1B$

$\mid 0$

$\mid 1$

Design a syntax-directed definition (SDD) for the above grammar such that the nonterminal  $F$  has an attribute  $Eval$  which keeps the decimal value of the binary fraction generated by  $F$ . Please use as few attributes as possible and do NOT modify the grammar.

【参考答案】

产生式	语义规则
$F \rightarrow 0.B$	$F.val = B.val$
$B \rightarrow 0B_1$	$B.val = B_1.val * 0.5$
$B \rightarrow 1B_1$	$B.val = 0.5 + B_1.val * 0.5$

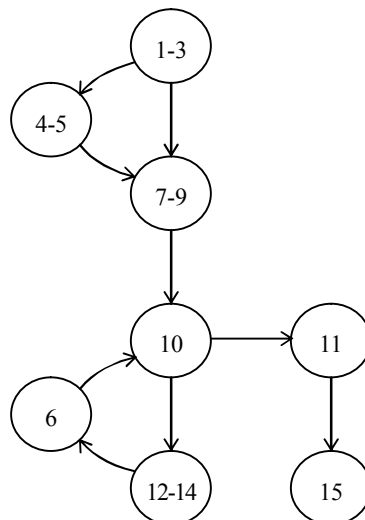
<b>B → 0</b>	<b>B.val = 0</b>
<b>B → 1</b>	<b>B.val = 0.5</b>

9. (8 points) Consider the following fragment of three-address instructions:

- (1)                **b := 1**
- (2)                **b := 2**
- (3)                **if w <= x goto B**
- (4)                **e := b**
- (5)                **jump B**
- (6)        **A:        jump D**
- (7)        **B:        c := 3**
- (8)                **b := 4**
- (9)                **c := 6**
- (10)       **D:        if y <= z goto E**
- (11)               **jump End**
- (12)       **E:        g := g + 1**
- (13)               **h := 8**
- (14)               **jump A**
- (15)       **End:     h := 9**

Please partition these three-address instructions into basic blocks, and draw the control flow graph. You may draw the resulting graph directly, but you must mark each node by number n~m indicating that the corresponding basic block consists of instructions n through m, inclusive.

【参考答案】



10. (12 points) Consider the following basic blocks:

- |                       |                       |
|-----------------------|-----------------------|
| (1) <b>T0 := 3.14</b> | (7) <b>B := A</b>     |
| (2) <b>T1 := 2*T0</b> | (8) <b>T5 := 2*T0</b> |
| (3) <b>T2 := R+r</b>  | (9) <b>T6 := R+r</b>  |

(4)  $T3 := R - r$                       (10)  $T7 := T3 - T5$

(5)  $T4 := T3 - T1$                     (11)  $B := A - T7$

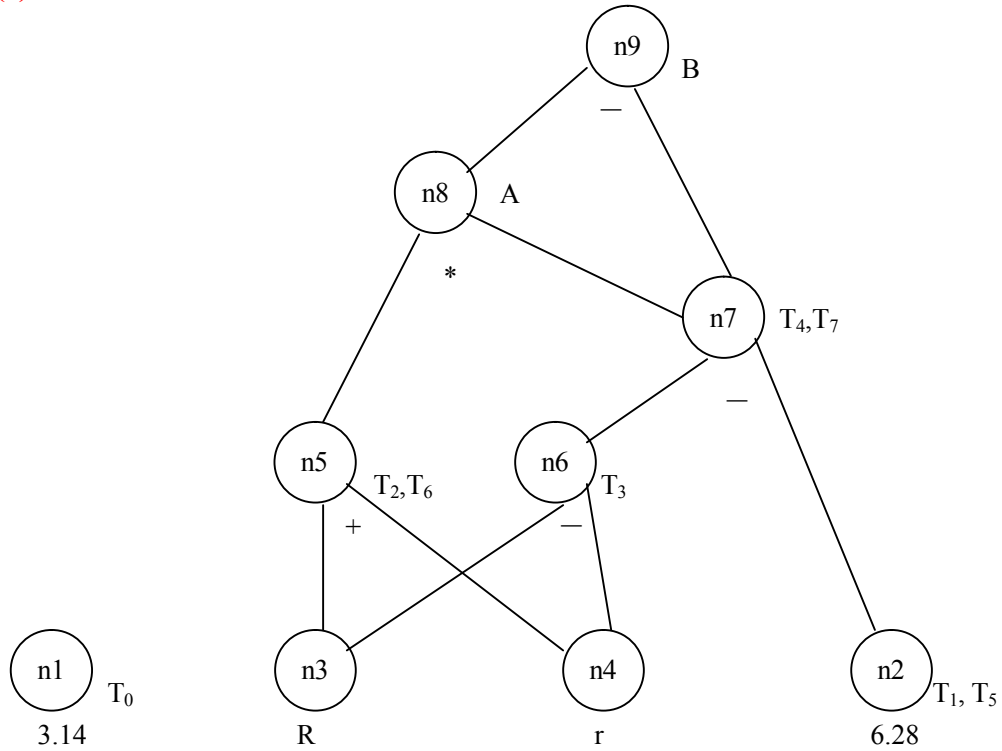
(6)  $A := T2 * T4$

(1) (7 points) Construct a DAG for this basic block.

(2) (5 points) Assuming that only A and B are live on exit from this basic block, simplify the three-address code.

【参考答案】

(1)



(2)

**S1 := R+r**

**S2 := R-r**

**S3 := S2-6.28**

**A := S1\*S3**

**B := A-S3**

注意本题中的临时变量 S1~S3 可以替换为其它名称.