习题 6.2 判断下列文法是不是 LL(1)文法，若不是，转换之。

(1) $\check{A} \to \varepsilon \mid \check{A}A;\quad A \to Td \mid Td[\check{I}]\quad T \to \text{int} \mid \text{float}\quad \check{I} \to i \mid \check{I},i$

(2) $S \to Ab\quad A \to a \mid B \mid \varepsilon\quad B \to b \mid \varepsilon$

(3) $S \to aSe \mid B\quad B \to bBe \mid C\quad C \to cCe \mid d$

(1) first($\check{A}$) = {ε, int, float}, first(A) = {int, float},

first(T) = {int, float}, first($\check{I}$) = i

follow($\check{A}$) = {int, float}, follow(A) = {;}

follow(T) = {d}, follow($\check{I}$) = {,,]}

∵ $\check{A} \to \varepsilon$ 且 first($\check{A}$) ∩ Follow($\check{A}$) ≠ ∅

∴ 不是 LL(1)文法，同样 A 的2个子式 first 集也重叠，它是左递归

∴ 修改如下：

$\check{A} \to AA' \mid \varepsilon$

$A' \to ;AA' \mid \varepsilon$

$A \to TdA''$

$A'' \to [\check{I}] \mid \varepsilon$

$T \to \text{int} \mid \text{float}$

$\check{I} \to i\check{I}'$

$\check{I}' \to ,i\check{I}' \mid \varepsilon$

(2)

	first	follow
S	{a, b}	{#}
A	{a, b, ε}	{b}
B	{b, ε}	{b}

∵ ε ∈ first(B)，且 follow(A) ∩ first(A) ≠ ∅

∴ 不是 LL(1)，修改如下

$S \to Ab$

$A \to a \mid b \mid \varepsilon$

(3)

	first	follow
S	{a, b, c, d}	{e}
B	{b, c, d}	{e}
C	{c, d}	{e}

因为 first(aSe) = {a}, first(B) = {b, c, d}

first(bBe) = {b}, first(C) = {c, d}

first(cCe) = {c}, first(d) = {d}

∴ 是 LL(1)

习题6.2；大作业（二）：对下列文法分别计算每个变元的FIRST集和FOLLOW集，然后从该文法中找出不满足LL(1)文法条件的各个原因。

$P \longrightarrow \check{D}\,\check{S}$

$\check{D} \longrightarrow \varepsilon \mid \check{D}\,D\,;$

$D \longrightarrow T\,d \mid T\,d[i] \mid T\,d(\check{A})\ \{\check{D}\,\check{S}\}$

$T \longrightarrow \text{int} \mid \text{void}$

$\check{A} \longrightarrow \varepsilon \mid \check{A}\,A\,;$

$A \longrightarrow T\,d \mid d[] \mid T\,d()$

$\check{S} \longrightarrow S \mid \check{S}\,;\,S$

$S \longrightarrow d = E \mid \text{if}\ (B)\ S \mid \text{if}\ (B)\ S\ \text{else}\ S \mid \text{while}\ (B)\ S$
$\mid \text{return}\ E \mid \{\check{S}\} \mid d(\check{R})$

$B \longrightarrow B \wedge B \mid B \vee B \mid E\,r\,E \mid E$

$E \longrightarrow d = E \mid i \mid d \mid d(\check{R}) \mid E + E \mid E * E \mid (E)$

$\check{R} \longrightarrow \varepsilon \mid \check{R}\,R\,,$

$R \longrightarrow E \mid d[] \mid d()$

可看出 $FIRST(T) = \{int, void\}$ $\therefore FIRST(\check{D}) = FIRST(T)$

$FIRST(\check{D}) = FIRST(D) \cup \{\varepsilon\} = \{int, void, \varepsilon\}$

$FIRST(A) = FIRST(D) \cup \{d\} = \{int, void, d\}$

$FIRST(\check{A}) = FIRST(A) \cup \{\varepsilon\} = \{int, void, d, \varepsilon\}$

$FIRST(S) = \{d, if, while, return, \{\}$

$FIRST(\check{S}) = FIRST(S)$

$FIRST(E) = \{d, i, (\}$，$FIRST(R) = FIRST(E) \cup \{d\}$

$FIRST(\check{R}) = \{\varepsilon\} \cup FIRST(R) = \{\varepsilon, d, i, (\}$

$FIRST(B) = FIRST(E) = \{d, i, (\}$

$FIRST(P) = FIRST(\check{D}) \cup FIRST(\check{S})$

综上可得 FIRST集如下

FIRST集

P:	int, void, ε, d, if, while, return, {
$\check{D}$:	int, void, ε
D:	int, void
T:	int, void
$\check{A}$:	int, void, d, ε
A:	int, void, d
$\check{S}$:	d, if, while, return, {
S:	d, if, while, return, {
B:	d, i, (
E:	d, i, (
$\check{R}$:	ε, d, i, (
R:	d, i, (

首先 FOLLOW(P) = {#} ①

根据 $D \to TD(\check{A}) \mid \{\check{D}\check{S}\}$, $\check{S} \to \check{S};S$, 得 FOLLOW($\check{S}$) = {#, }, ; } ②

∵ $\check{D} \to \check{D}D;$ ∴ FOLLOW($\check{D}$) = {;} ③

∵ $\check{D} \to \varepsilon \mid \check{D}D;$ ∴ FOLLOW($\check{D}$) ⊇ FIRST(D)

∵ $P \to \check{D}\check{S}$ ∴ FOLLOW($\check{D}$) = FIRST(D) ∪ FIRST($\check{S}$) = {int, void, d, if, while, return, { } ④

∵ $\check{A} \to \check{A}A;$ ∴ FOLLOW(A) = {;} ⑤, 同理 FOLLOW(R) ⊇ {, }

∵ $\check{R} \to \varepsilon \mid \check{R}R,$ ∴ FOLLOW(R) ⊇ FOLLOW($\check{R}$)

而 FOLLOW($\check{R}$) = {) } ⑥ ∴ FOLLOW(R) = {), , } ⑦

∵ $A \to Td$ ∴ FOLLOW(T) = {d} ⑧

∵ $D \to Td(\check{A})$ ∴ FOLLOW($\check{A}$) = {) } ⑨

∵ $E \to E+E \mid E*E \mid (E)$ ∴ FOLLOW(E) ⊇ {+, *,)}

∵ $R \to E$ ∴ FOLLOW(E) ⊇ FOLLOW(R) = {, }

∵ $B \to E\ r\ E$ ∴ FOLLOW(E) ⊇ {+, *,), ,, r}

∵ $S \to if(B)S$ ∴ FOLLOW(B) = {)} ⑩

∵ $\check{S} \to S$ ∴ FOLLOW(S) ⊇ FOLLOW($\check{S}$)

∵ $S \to if(B)S\ else\ S$ ∴ FOLLOW(S) = {}, ;, else} ⑪

∵ $S \to d=E$ ∴ FOLLOW(E) ⊇ FOLLOW(S)

∴ FOLLOW(E) = {+, *,), ,, r, }, ;, else} ⑫

综上，FOLLOW集如下：

	FOLLOW集
P	#
$\check{D}$	int, void, d, if, while, return, {
D	;
T	d
$\check{A}$	)
A	;
$\check{S}$	;, }, #
S	;, else, }
B	)
E	+, *,), ,, r, }, ;, else
$\check{R}$	)
R	), ,

不满足的原因：

① 对 $\check{D} \to \varepsilon | \check{D}D;$ ∵ FIRST($\check{D}$) ∩ FOLLOW($\check{D}$) ≠ ∅

∴ 不满足 LL(1)

② 对 $D \to Td[TdCi]$ ∵ FIRST(Td) ∩ FIRST(TdCi) ≠ ∅

∴ 不满足 LL(1)

③ 对 $\check{A} \to \varepsilon | \check{A}A$，属于左递归 ∴ 不满足 LL(1)

④ 对 A→Td|Td(), 同③, 不满足 LL(1)

⑤ S̆→S|S̆;S 仍是左递归

⑥ S→d=E|d(R̆), 同②, 不满足 LL(1)

⑦ B→B∧B|B∨B, 同②, 不满足 LL(1)

⑧ E→d=E|d|d(R̆), 同②, 不满足 LL(1)

⑨ R̆→ε|R̆R 仍是左递归 ∴不满足 LL(1)

⑩ R→d[]|d(), 同②, 不满足 LL(1)