A2 sol

Q1

(a)

G_1:
1. $P \to S\ \$\$$
2. $S \to (S)\ S$
3. $S \to [S]\ S$
4. $S \to \varepsilon$

	FIRST	FOLLOW
P	(, [	$\emptyset$
S	(, [	$\$\$$,),]

Parse table:

nonterm. \ input	(	)	[	]	$$
P	1		1		1
S	2	4	3	4	4

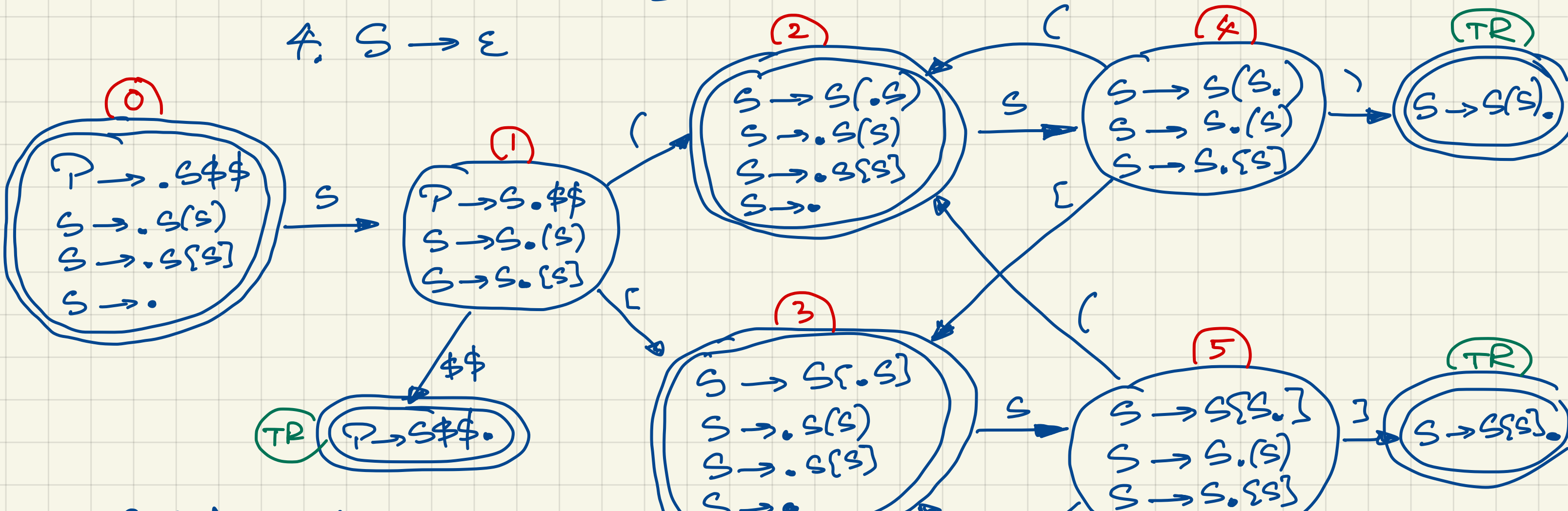
G_1 is LL(1) because each cell in the parse table has at most one entry.

(b)

G_2:
1. $P \to S\ \$\$$
2. $S \to S(S)$
3. $S \to S[S]$

} → not LL(1)

4. $S \to \varepsilon$



- trivial states not used (TR)

Parse table:

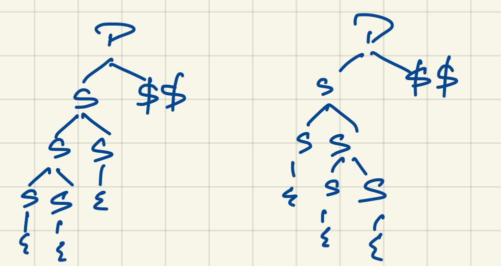
state \ input	S	(	)	[	]	$$
0	s1	r4	r4	r4	r4	r4
1		s2		s3		b1
2	s4	r4	r4	r4	r4	r4
3	s5	r4	r4	r4	r4	r4
4		s2	b2	s3		
5		s2		s3	b3	

There is no conflict, so G_2 is SLR(1)

(c)

G_3:
$P \to S\ \$\$$
$S \to SS$
$S \to (S)$
$S \to \varepsilon$

G_3 is ambiguous: therefore not SLR(1)

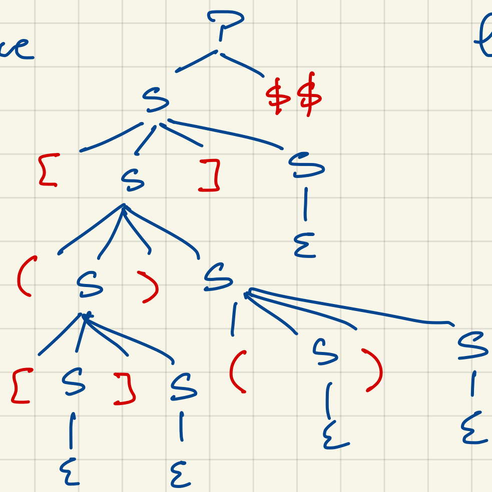


Alternative proof for not SLR(1):

$P \to .S\$\$$
$S \to .SS$
$S \to .(S)$
$S \to .$

- shift/reduce conflict on '('
  - shift: $S \to (.S)$
  - reduce: $S \to .$, '(' $\in$ FOLLOW(S)

(d) G, parse tree



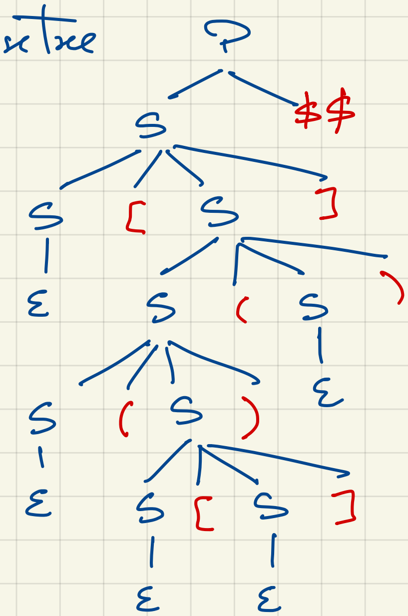
left derivation:

$P \Rightarrow S\$\$ \Rightarrow [S]S\$\$ \Rightarrow [(S)S]S\$\$$
$\Rightarrow [([S]S)S]S\$\$ \Rightarrow [([]S)S]S\$\$$
$\Rightarrow [([])S]S\$\$ \Rightarrow [([])(S)S]S\$\$$
$\Rightarrow [([])()S]S\$\$ \Rightarrow [([])()]S\$\$$
$\Rightarrow [([])()]\$\$$

(e)

Parse stack	Input stream	Comment
P	[([])()]$$	
S$$	[([])()]$$	predict P → S$$
[S]S$$	[([])()]$$	S → [S]S
S]S$$	([])()]$$	match [
(S)S]S$$	([])()]$$	predict S → (S)S
S)S]S$$	[])()]$$	match (
[S]S)S]S$$	[])()]$$	predict S → [S]S
S]S)S]S$$	])()]$$	match [
]S)S]S$$	])()]$$	predict S → ε
S)S]S$$	)()]$$	match]
)S]S$$	)()]$$	predict S → ε
S]S$$	()]$$	match
(S)S]S$$	()]$$	predict S → (S)S
S)S]S$$	)]$$	match (
)S]S$$	)]$$	predict S → ε
S]S$$	]$$	match)
]S$$	]$$	predict S → ε
S$$	$$	match]
$$	$$	predict S → ε
		match $$

(f) G_2 parse tree



right derivation:

$P \Rightarrow S\$\$ \Rightarrow S[S]\$\$$

$\Rightarrow S[S(S)]\$\$ \Rightarrow S[S()]\$\$$

$\Rightarrow S[S(S)()]\$\$ \Rightarrow S[S(S[S])()]\$\$$

$\Rightarrow S[S(S[])()]\$\$ \Rightarrow S[S([])()]\$\$$

$\Rightarrow S[([])()]\$\$ \Rightarrow [([])()]\$\$$

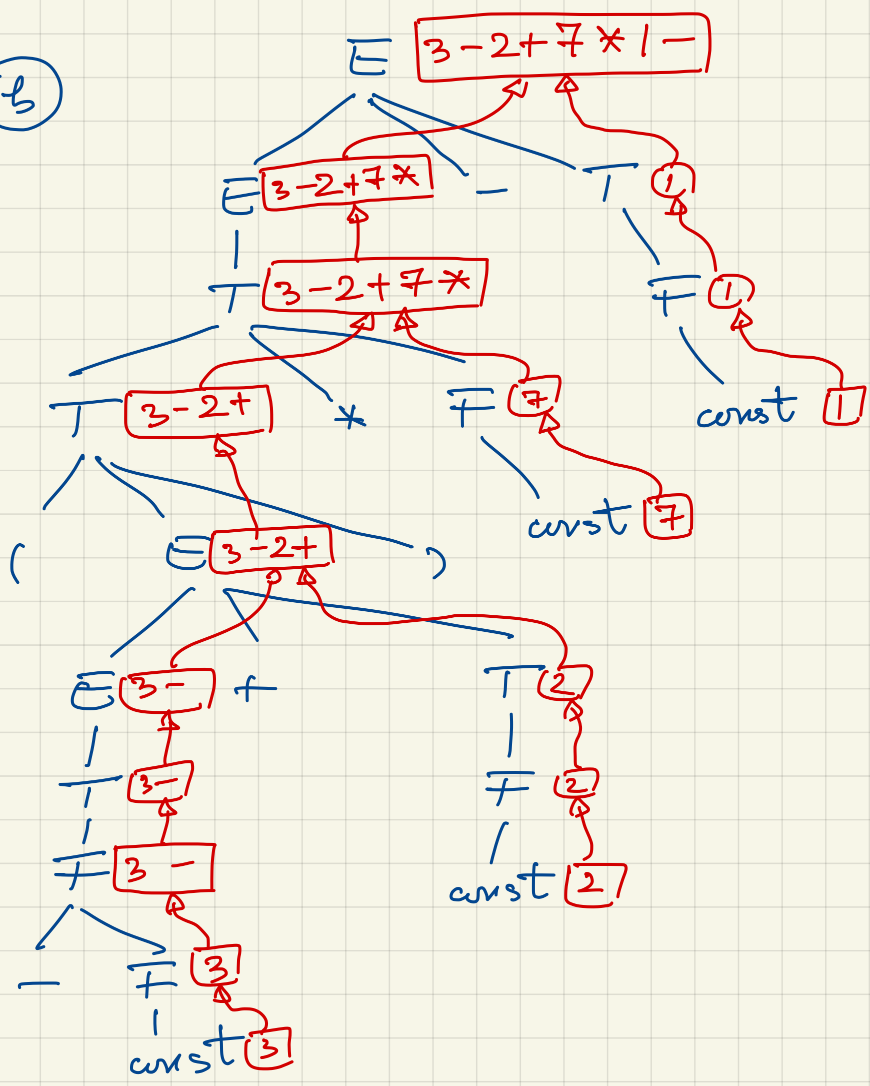
(g)

Parse stack	Input stream	Comment
0	[([])()]$$	
0	S[([])()]$$	reduce by $S \to \varepsilon$
0S1	[([])()]$$	shift S
0S1[3	([])()]$$	shift [
0S1[3	S([])()]$$	reduce by $S \to \varepsilon$
0S1[3S5	([])()]$$	shift S
0S1[3S5(2	[])()]$$	shift (
0S1[3S5(2	S[])()]$$	reduce by $S \to \varepsilon$
0S1[3S5(2S4	[])()]$$	shift S
0S1[3S5(2S4[3	])()]$$	shift [
0S1[3S5(2S4[3	S])()]$$	reduce by $S \to \varepsilon$
0S1[3S5(2S4[3S5	])()]$$	shift S
0S1[3S5(2	S)()]$$	shift and reduce by $S \to S[S]$
0S1[3S5(2S4	)()]$$	shift S
0S1[3	S()]$$	shift and reduce by $S \to S(S)$
0S1[3S5	()]$$	shift S
0S1[3S5(2	)]$$	shift (
0S1[3S5(2	S)]$$	reduce by $S \to \varepsilon$
0S1[3S5(2S4	)]$$	shift S
0S1[3	S]$$	shift and reduce by $S \to S(S)$
0S1[3S5	]$$	shift S
0	S$$	shift and reduce by $S \to S[S]$
0S1	$$	shift S
0	P	shift and reduce by $P \to S\$\$$

Q2 (a) We use one synthesized attribute s, for the string associated with a node.

$E_1 \to E_2 + T$	▷ $E_1.s = concat(E_2.s, T.s, '+')$
$E_1 \to E_2 - T$	▷ $E_1.s = concat(E_2.s, T.s, '-')$
$E \to T$	▷ $E.s = T.s$
$T_1 \to T_2 * F$	▷ $T_1.s = concat(T_2.s, F.s, *)$
$T_1 \to T_2 / F$	▷ $T_1.s = concat(T_2.s, F.s, '/')$
$T \to F$	▷ $T.s = F.s$
$F_1 \to -F_2$	▷ $F_1.s = concat(F_2.s, '-')$
$F \to (E)$	▷ $F.s = E.s$
$F \to const$	▷ $F.s = str(const)$ (or just const)

(b)



(c) We use one synthesized attribute, s, for string and an inherited one, p, for partial string.

$E \to T\ TT$ $\quad \triangleright TT.p = T.s \quad \triangleright E.s = TT.s$

$TT_1 \to +\ T\ TT_2$ $\quad \triangleright TT_2.p = concat(TT_1.p, T.s, '+') \quad \triangleright TT_1.s = TT_2.s$

$TT_1 \to -\ T\ TT_2$ $\quad \triangleright TT_2.p = concat(TT_1.p, T.s, '-') \quad \triangleright TT_1.s = TT_2.s$

$TT \to \varepsilon$ $\quad \triangleright TT.s = TT.p$

$T \to F\ FT$ $\quad \triangleright FT.p = F.s \quad \triangleright T.s = FT.s$

$FT_1 \to *\ F\ FT_2$ $\quad \triangleright FT_2.p = concat(FT_1.p, F.s, '*') \quad \triangleright FT_1.s = FT_2.s$

$FT_1 \to /\ F\ FT_2$ $\quad \triangleright FT_2.p = concat(FT_1.p, F.s, '/') \quad \triangleright FT_1.s = FT_2.s$

$FT \to \varepsilon$ $\quad \triangleright FT.s = FT.p$

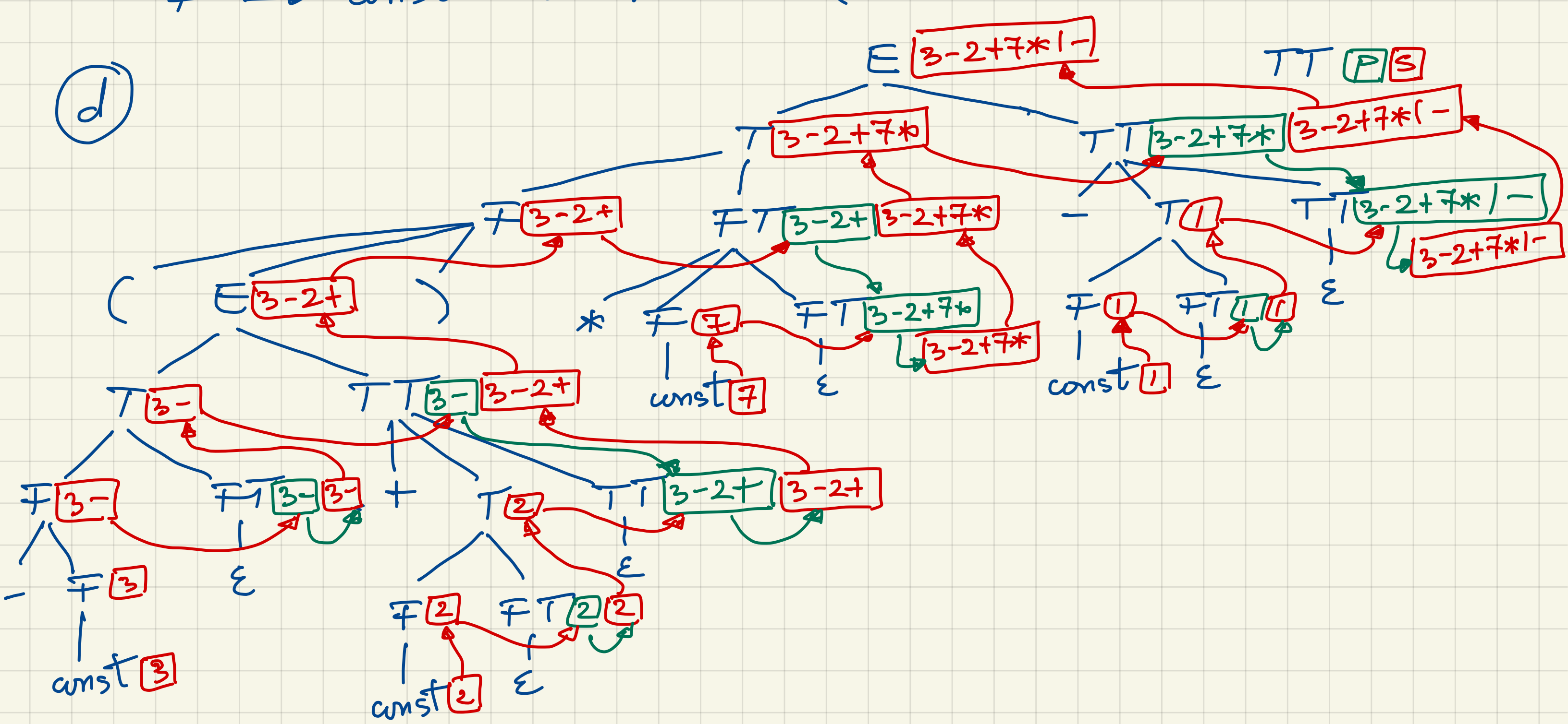
$F_1 \to -\ F_2$ $\quad \triangleright F_1.s = concat(F_2.s, '-')$

$F \to (\ E\ )$ $\quad \triangleright F.s = E.s$

$F \to const$ $\quad \triangleright F.s = str(const)$

$(-3+2)*7-1$

(d)



Q3 (a) Besides the val attribute, we'll use pos for the position of the digit.

Production	Semantic rules
Float → Left . Right	Float.val = Left.val + Right.val Right.pos = 0
Left → Digit Left_more	Left.val = Digit.val + Left_more.val Left.pos = Left_more.pos + 1 Digit.pos = Left_more.pos
Left_more → Left	Left_more.val = Left.val Left_more.pos = Left.pos
Left_more → ε	Left_more.val = Left_more.pos = 0
Right → Digit Right_more	Right.val = Digit.val + Right_more.val Right_more.pos = Right.pos − 1 Digit.pos = Right_more.pos
Right_more → Right	Right_more.val = Right.val Right.pos = Right_more.pos
Right_more → ε	Right_more.val = 0
Digit → i	Digit.val = $i \cdot 10^{\text{Digit.pos}}$

(b)