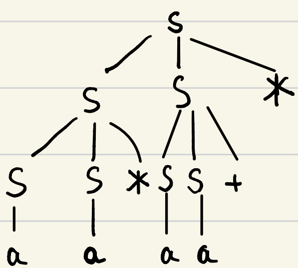
# Exercise 1

1. $S \Rightarrow SS* \Rightarrow SS*S* \Rightarrow aS*S* \Rightarrow aa*S* \Rightarrow aa*SS+* \Rightarrow aa*aS+*$
$\Downarrow$
$aa*aa+*$

2. $S \Rightarrow SS* \Rightarrow SSS+* \Rightarrow SSa+* \Rightarrow Saa+* \Rightarrow SS*aa+* \Rightarrow Sa*aa+*$
$\Downarrow$
$aa*aa+*$

3. 

4. $S \rightarrow aS'$
$S' \rightarrow S+S' \mid S*S' \mid \varepsilon$

5. No

Exercise 2.

1. ① FIRST(a) = {a}, FIRST(*) = {*}

② Since $B \to S * B \mid \varepsilon$, $\varepsilon \in$ FIRST(B),

③ Since $S \to aB$, $B \to S * B$, $a \in$ FIRST(S), FIRST(B) $\supseteq$ FIRST(S)

④ FIRST(S) = {a}, FIRST(B) = {a, ε}

⑤ Since S is the starting symbol, $\$ \in$ FOLLOW(S),

Since $B \to S * B \mid \varepsilon$ and $S \to aB$, we can derive that $B \to aB * B$, $* \in$ FOLLOW(B)

⑥ FOLLOW(S) = FOLLOW(B) = {*, $}

⑦ Since FIRST(aB) = FIRST(a) = a, add $S \to aB$ in M[S, a]

for $B \to S * B$, FIRST(S * B) = FIRST(S) = a, add $B \to S * B$ in M[B, a]

for $B \to \varepsilon$, since FOLLOW(B) = {*, $}, add $B \to \varepsilon$ in M[B, *] and M[B, $]

output $S \to aB$

| Non-terminal symbol | Input symbols | | |
|---|---|---|---|
| | a | * | $ |
| S | $S \to aB$ | | |
| B | $B \to S*B$ | $B \to \varepsilon$ | $B \to \varepsilon$ |

2. Yes.

3. Yes, it can

| Matched | Stack | Input | Action |
|---|---|---|---|
| | S $ | aaaa***$ | |
| | aB $ | aaaa***$ | output $S \to aB$ |
| a | B $ | aaa***$ | match a |
| a | S*B$ | aaa***$ | output $B \to S*B$ |
| a | aB*B$ | aaa***$ | output $S \to aB$ |
| aa | B*B $ | aa***$ | match a |
| aa | S*B*B$ | aa***$ | output $B \to S*B$ |

| | | | |
|---|---|---|---|
| aa | $aB*B*B\$$ | $aa***\$$ | output $S \to aB$ |
| aaa | $B*B*B\$$ | $a***\$$ | match a |
| aaa | $S*B*B*B\$$ | $a***\$$ | output $B \to S*B$ |
| aaa | $aB*B*B*B\$$ | $a***\$$ | output $S \to aB$ |
| aaaa | $B*B*B*B\$$ | $***\$$ | match a |
| aaaa | $*B*B*B\$$ | $***\$$ | output $B \to \varepsilon$ |
| aaaa* | $B*B*B\$$ | $**\$$ | match * |
| aaaa* | $*B*B\$$ | $**\$$ | output $B \to \varepsilon$ |
| aaaa** | $B*B\$$ | $*\$$ | match * |
| aaaa** | $*B\$$ | $*\$$ | output $B \to \varepsilon$ |
| aaaa*** | $B\$$ | $\$$ | match * |
| aaaa*** | $\$$ | $\$$ | output $B \to \varepsilon$ |

so LL(1) can accept aaaa***

Exercise 3

$$S \to SS+ \mid SS* \mid a$$

proof: Since there are only one pattern to choose when it meets a terminal input such as "+" or "*", it will not generate two parse tree corresponding to a certain sentence

So it's unambiguous.