

CHAPTER 3 SOLUTIONS

3.

```
<assign> → <id> = <expr> <id> → A | B | C  
<expr> → <expr> * <term> | <term>  
<term> → <factor> + <term> | <factor>  
<factor> → ( <expr> )  
           | <id>
```

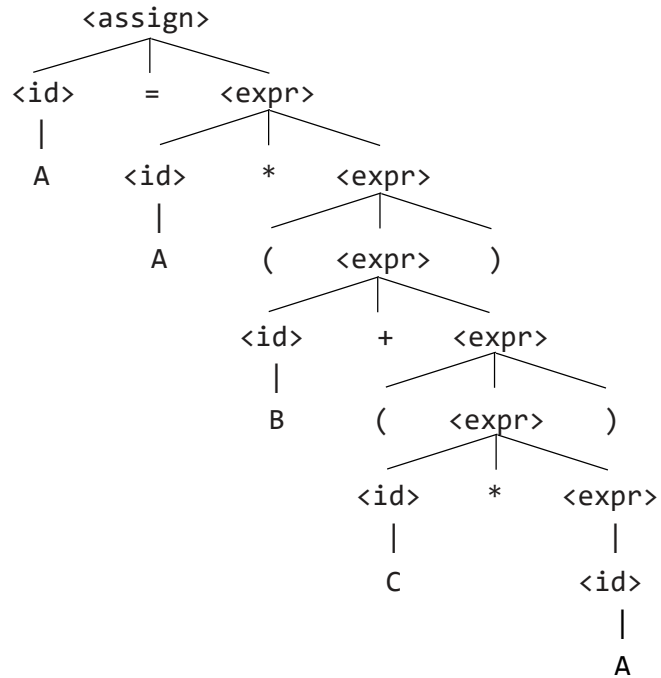
4.

```
<assign> -> <id> = <expr>  
<id> -> A | B | C  
<expr> -> <expr> + <term>  
         | <term>  
<term> -> <term> * <factor>  
         | <factor>  
<factor> -> ( <expr> )  
           | <id>  
           | <id> ++  
           | <id> - -
```

6.

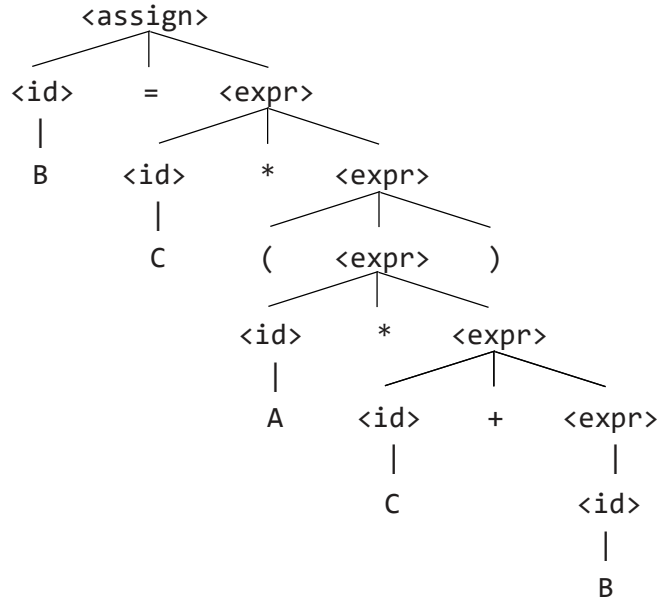
a) $A = A * (B + (C * A))$

```
<assign> => <id> = <expr>  
=> A = <expr>  
=> A = <id> * <expr>  
=> A = A * <expr>  
=> A = A * ( <expr> )  
=> A = A * ( <id> + <expr> )  
=> A = A * ( B + <expr> )  
=> A = A * ( B + ( <expr> ) )  
=> A = A * ( B + ( <id> * <expr> ) )  
=> A = A * ( B + ( C * <expr> ) )  
=> A = A * ( B + ( C * <id> ) )  
=> A = A * ( B + ( C * A ) )
```



b) $B = C * (A * C + B)$

$\langle \text{assign} \rangle \Rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$
 $\Rightarrow B = \langle \text{expr} \rangle$
 $\Rightarrow B = \langle \text{id} \rangle * \langle \text{expr} \rangle$
 $\Rightarrow B = C * \langle \text{expr} \rangle$
 $\Rightarrow B = C * (\langle \text{expr} \rangle)$
 $\Rightarrow B = C * (\langle \text{id} \rangle * \langle \text{expr} \rangle)$
 $\Rightarrow B = C * (A * \langle \text{expr} \rangle)$
 $\Rightarrow B = C * (A * \langle \text{id} \rangle + \langle \text{expr} \rangle)$
 $\Rightarrow B = C * (A * C + \langle \text{expr} \rangle)$
 $\Rightarrow B = C * (A * C + \langle \text{id} \rangle)$
 $\Rightarrow B = C * (A * C + B)$



c) $A = A * (B + (C))$

$\langle \text{assign} \rangle \Rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$

$\Rightarrow A = \langle \text{expr} \rangle$

$\Rightarrow A = \langle \text{id} \rangle * \langle \text{expr} \rangle$

$\Rightarrow A = A * \langle \text{expr} \rangle$

$\Rightarrow A = A * (\langle \text{expr} \rangle)$

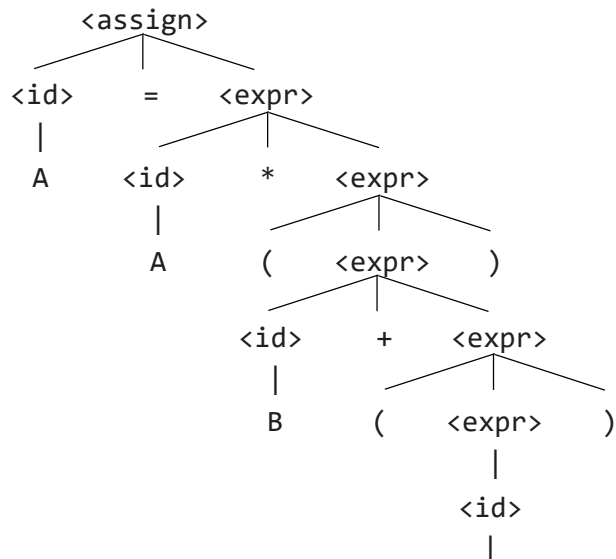
$\Rightarrow A = A * (\langle \text{id} \rangle + \langle \text{expr} \rangle)$

$\Rightarrow A = A * (B + \langle \text{expr} \rangle)$

$\Rightarrow A = A * (B + (\langle \text{expr} \rangle))$

$\Rightarrow A = A * (B + (\langle \text{id} \rangle))$

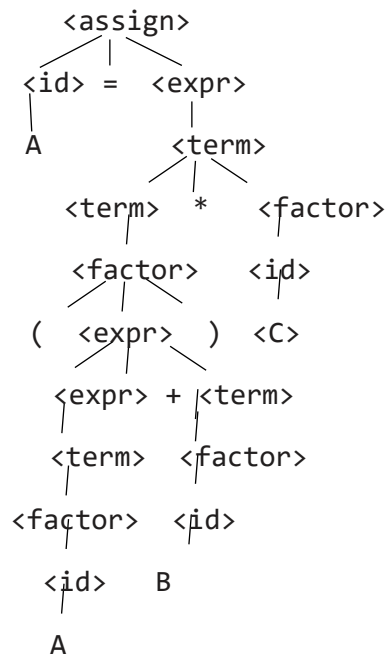
$\Rightarrow A = A * (B + (C))$



7.

a. $A = (A + B) * C$ $\langle \text{assign} \rangle \Rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$ $\Rightarrow A = \langle \text{expr} \rangle$ $\Rightarrow A = \langle \text{term} \rangle$ $\Rightarrow A = \langle \text{term} \rangle * \langle \text{factor} \rangle$ $\Rightarrow A = \langle \text{factor} \rangle * \langle \text{factor} \rangle$ $\Rightarrow A = (\langle \text{expr} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (\langle \text{expr} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (\langle \text{term} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (\langle \text{factor} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (\langle \text{id} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (A + \langle \text{factor} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (A + \langle \text{id} \rangle) * \langle \text{factor} \rangle$ $\Rightarrow A = (A + B) * \langle \text{factor} \rangle$ $\Rightarrow A = (A + B) * \langle \text{id} \rangle$ $\Rightarrow A = (A + B) * C$

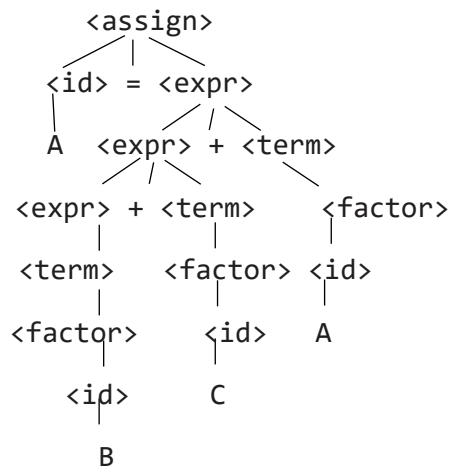
Parse Tree



b. $A = B + C + A$

$\langle \text{assign} \rangle \Rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$
 $\Rightarrow A = \langle \text{expr} \rangle$
 $\Rightarrow A = \langle \text{expr} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = \langle \text{expr} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = \langle \text{term} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = \langle \text{factor} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = \langle \text{id} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = B + \langle \text{term} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = B + \langle \text{factor} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = B + \langle \text{id} \rangle + \langle \text{term} \rangle$
 $\Rightarrow A = B + C + \langle \text{term} \rangle$
 $\Rightarrow A = B + C + \langle \text{factor} \rangle$
 $\Rightarrow A = B + C + \langle \text{id} \rangle$
 $\Rightarrow A = B + C + A$

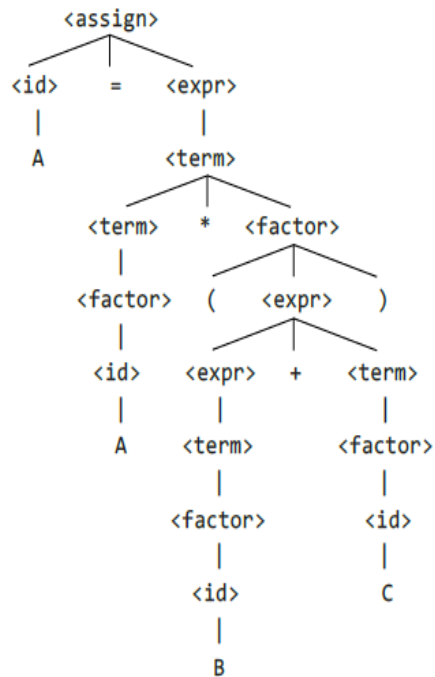
Parse Tree



c. $A = A * (B + C)$

$\langle \text{assign} \rangle \Rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$
 $\Rightarrow A = \langle \text{expr} \rangle$
 $\Rightarrow A = \langle \text{term} \rangle$
 $\Rightarrow A = \langle \text{term} \rangle * \langle \text{factor} \rangle$
 $\Rightarrow A = \langle \text{factor} \rangle * \langle \text{factor} \rangle$
 $\Rightarrow A = \langle \text{id} \rangle * \langle \text{factor} \rangle$

$\Rightarrow A = A * \langle \text{factor} \rangle$
 $\Rightarrow A = A * (\langle \text{expr} \rangle)$
 $\Rightarrow A = A * (\langle \text{expr} \rangle + \langle \text{term} \rangle)$
 $\Rightarrow A = A * (\langle \text{term} \rangle + \langle \text{term} \rangle)$
 $\Rightarrow A = A * (\langle \text{factor} \rangle + \langle \text{term} \rangle)$
 $\Rightarrow A = A * (\langle \text{id} \rangle + \langle \text{term} \rangle)$
 $\Rightarrow A = A * (B + \langle \text{term} \rangle)$
 $\Rightarrow A = A * (B + \langle \text{factor} \rangle)$
 $\Rightarrow A = A * (B + \langle \text{id} \rangle)$
 $\Rightarrow A = A * (B + C)$

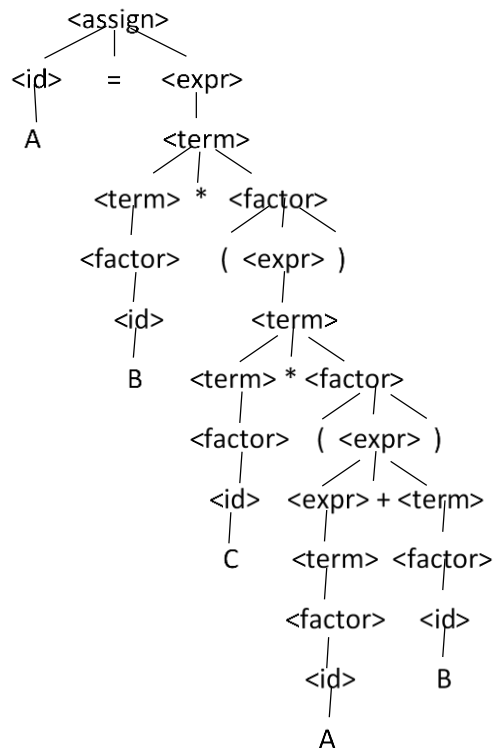


d. $A = B * (C * (A + B))$

$\langle \text{assign} \rangle \Rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$
 $\Rightarrow A = \langle \text{expr} \rangle$
 $\Rightarrow A = \langle \text{term} \rangle$
 $\Rightarrow A = \langle \text{term} \rangle * \langle \text{factor} \rangle$
 $\Rightarrow A = \langle \text{factor} \rangle * \langle \text{factor} \rangle$
 $\Rightarrow A = \langle \text{id} \rangle * \langle \text{factor} \rangle$
 $\Rightarrow A = B * \langle \text{factor} \rangle$
 $\Rightarrow A = B * (\langle \text{expr} \rangle)$
 $\Rightarrow A = B * (\langle \text{term} \rangle)$
 $\Rightarrow A = B * (\langle \text{term} \rangle * \langle \text{factor} \rangle)$

$\Rightarrow A = B * (<factor>*<factor>)$
 $\Rightarrow A = B * (<id>*<factor>)$
 $\Rightarrow A = B * (C*<factor>)$
 $\Rightarrow A = B * (C*(<expr>))$
 $\Rightarrow A = B * (C*(<expr>+<term>))$
 $\Rightarrow A = B * (C*(<term>+<term>))$
 $\Rightarrow A = B * (C*(<factor>+<term>))$
 $\Rightarrow A = B * (C*(<id>+<term>))$
 $\Rightarrow A = B * (C*(A+<term>))$
 $\Rightarrow A = B * (C*(A+<factor>))$
 $\Rightarrow A = B * (C*(A+<id>))$
 $\Rightarrow A = B * (C*(A+B))$

Parse Tree



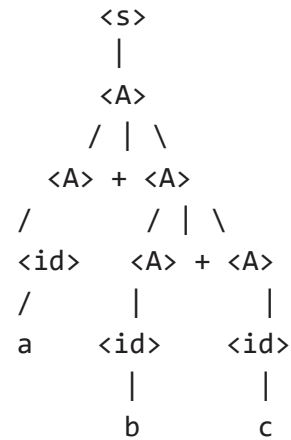
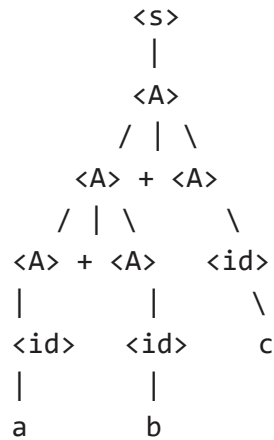
8.

$\langle S \rangle \rightarrow \langle A \rangle$

$\langle A \rangle \rightarrow \langle A \rangle + \langle A \rangle \mid \langle id \rangle$

$\langle id \rangle \rightarrow a \mid b \mid c$

Take "a+b+c" as example, it has two possible parse trees:



which will cause the ambiguity.

11.

$\langle S \rangle \rightarrow \langle A \rangle a \langle B \rangle b$

$\langle A \rangle \rightarrow \langle A \rangle b \mid b$

$\langle B \rangle \rightarrow a \langle B \rangle \mid a$

This BNF can be represented in EBNF:

$S = "b", \{ "b" \}, "a", "a", \{ "a" \}, "b";$

Thus, "baab" and "bbaab" are generated by this grammar; "bbbab" and "bbaaaaa" are not.

The answer is (a) (d).

12.

$\langle S \rangle \rightarrow a \langle S \rangle c \langle B \rangle \mid \langle A \rangle \mid b$

$\langle A \rangle \rightarrow c \langle A \rangle \mid c$

$\langle B \rangle \rightarrow d \mid \langle A \rangle$

This BNF can be represented in EBNF:

$S = "a", S, "c", ("d" \mid "c", \{ "c" \}) \mid "c", \{ "c" \} \mid "b";$

Thus, "abcd" and "accc" are generated by this grammar; the others are not.

The answer is (a) (e).

13.

Derivation -

$\langle S \rangle \Rightarrow a b \mid a \langle S \rangle b$

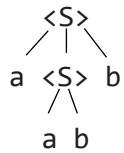
14.

For sentence aabb:

Derivation -

$\langle S \rangle \Rightarrow a \langle S \rangle b$
 $\Rightarrow a a b b$

Parse Tree



For sentence aaaabbbb:

Derivation -

$\langle S \rangle \Rightarrow a \langle S \rangle b$
 $\Rightarrow a a \langle S \rangle b b$
 $\Rightarrow a a a \langle S \rangle b b b$
 $\Rightarrow a a a a b b b b$

Parse Tree

