12. Consider the following grammar:

\[ <S> \rightarrow a <S> c <B> | <A> | b \]
\[ <A> \rightarrow c <A> | c \]
\[ <B> \rightarrow d | <A> \]

Which of the following sentences are in the language generated by this grammar?

A. abcd

\[
\begin{array}{c}
\text{S} \\
\text{a} \quad \text{S} \quad \text{c} \quad \text{B} \\
\quad b \\
\quad d
\end{array}
\]

- According to the parse tree, the sentence is generated by the grammar.

B. acccbd
- The sentence cannot be generated because the parse tree cannot continue any further after <B>.

C. accbcc

```
< S >
  /   \
 a    < S >
  \     |
   c   < A >
        c
```

- The sentence cannot be generated because the parse tree cannot continue any further after <B>.

D. acd

```
< S >
  /   \
 a    < S >
  \     |
   c   < B >
       d
```

- The sentence cannot be generated because the parse tree cannot continue any further after <S>.
According to the parse tree, the sentence is generated by the grammar.

13. Write a grammar for the language consisting of strings that have $n$ copies of the letter $a$ followed by the same number of copies of the letter $b$, where $n > 0$. For example, the strings $ab$, $aaaabbb$, and $aaaaaaaaabbbbbb$ are in the language but $a$, $abb$, $ba$, and $aaabb$ are not.

$$<S> \rightarrow a <S> b | ab$$

14. Draw parse trees for the sentences $aabb$ and $aaaabbb$, as derived from the grammar of problem 13.

A. $aabb$
16. Convert the BNF of Example 3.3 to EBNF.

\[
\begin{align*}
\text{<assign>} & \rightarrow \text{id} = \text{<expr>} \\
\text{id} & \rightarrow A | B | C \\
\text{<expr>} & \rightarrow \text{<expr>} \{ ( + | * ) \text{<expr>} \} \\
& \quad | ( \text{<expr>} ) \\
& \quad | \text{id}
\end{align*}
\]
17. Convert the following EBNF to BNF:

\[
S \to A \{bA\} \\
A \to a \ [b]A
\]

**Darren Potts’ answer for #17 -**

\[
<S> \to <S>b<A> \mid <A> \\
<A> \to a<A> \mid ab<A>
\]