1. [10pts] Rewrite the BNF grammar above to give + precedence over * and force + to be right associative.

2. [10pts] Using the grammar above, show a parse tree and a leftmost derivation for each of the following statements:
   a. \( A = ( A + B ) * C \)
   b. \( A = B * ( C * ( A + B ) ) \)

3. [5pts] Rewrite the BNF grammar above in EBNF

4. [10pts] Prove that the following grammar is ambiguous:

   \[
   S \rightarrow A \\
   A \rightarrow A + A + A | \text{id} \\
   \text{id} \rightarrow \text{a} | \text{b} | \text{c}
   \]

   Just show me two parse trees that map to the same statement

5. [10pts] Consider the following grammar:

   \[
   S \rightarrow A \ a \ B \ b \\
   A \rightarrow A \ b \ | \ b \\
   B \rightarrow a \ B \ | \ a
   \]

   Which of the following sentences are in the language generated by this grammar?
   a. \( \text{baab} \)  
   b. \( \text{bbbab} \)  
   c. \( \text{bbaaaaa} \)  
   d. \( \text{bbabaab} \)  
   e. \( \text{babab} \)

6. [10pts] 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 \( n > 0 \).

7. [5pts] Write an attribute grammar whose BNF basis is the grammar below but whose language rules are as follows:
   Data types cannot be mixed in expressions, but assignment statements need not have the same types on both sides of the assignment operator.

   \[
   \text{assign} \rightarrow \text{id} = \text{expr} \\
   \text{expr} \rightarrow \text{id} + \text{term} | \text{term} \\
   \text{term} \rightarrow \text{factor} * \text{term} | \text{factor} \\
   \text{factor} \rightarrow ( \text{expr} ) | \text{id}
   \]

   Write the SEMANTIC rules for determining the type from a variable
   HINT: look at the slides r.e. LOOKUP
   Write the SEMANTIC rule for determining type match/mismatch for expressions
   BONUS: If you don’t need to check a type, you don’t need to specify a semantic rule

8. [10pts] Compute the weakest precondition for each of the following:
   a. \( a = 2 \cdot (b - 1) - 1 \) 
      \( \{ a > 0 \} \)  
      e.g. suppose we have \( c = b + 2, \{ b > 2 \} \)
   b. \( a = 2 \cdot b + 1; \)  
      \( b = a - 3; \)  
      \( \{ b > 2 \} \)  
      \( b = c + 2 \)  
      \( \{ b < 0 \} \)  
      \( c + 2 > 2 \)
   therefore, \( \{ c > 4 \} \)