CSCI 330 Problems (Chapter 3)

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(50 pts)

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

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

2. Using the grammar provided 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. Prove that the following grammar is ambiguous:

```
<S> -> <A>
<A> -> <A> + <A> + <A> | <id>
<id> -> a | b | c
```

4. Consider the following grammar:

```
<S> -> <A> a <B> b
<A> -> <A> b | b
<B> -> a <B> | a
```

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

   a. baab
   b. bbbab
   c. bbaaaaa
   d. bbaab

5. 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.

6. 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.

```
<assign> -> <var> = <expr>
<expr> -> <var>[2] + <var>[3] | <var>
<var> -> A | B | C
```

7. Consider the syntax rule and the semantic function below:
   <bin_num> -> '0' | '1' | <bin_num> '0' | <bin_num> '1'
   $M_{bin}$('0') = 0
   $M_{bin}$('1') = 1
   $M_{bin}$(<bin_num> '0') = 2 * $M_{bin}$(<bin_num> )
   $M_{bin}$(<bin_num> '1') = 2 * $M_{bin}$(<bin_num> ) + 1

   What is the value of the sequence of characters '1001'? (Show your work)

8. Axiomatic Semantics

   Compute the weakest precondition for each of the following:

   a. `a = 2 * (b - 1) - 1 {a > 0}`
   b.
   ```
   a = 2 * b + 1;
   b = a - 3;
   {b < 0}
   ```

   Prove that the following program segment is correct:

   c.
   ```
   {b > 4}
   c = b - 3;
   a = c + 2;
   {a >= 2}
   ```