

Midterm, CSCI 360, Fall 2004

Name: _____

1. [10 pts] Using BNF notation, describe a context-free grammar for the language of strings consisting of a sequence of a 's, followed by b 's, followed by c 's, in which there are as many c 's as there are a 's and b 's put together. Examples include $aacc$ and $aabccc$, but not $accb$ or $aaabccc$.
2. [10 pts] Give an unambiguous grammar that produces the same set of strings as the following. (Your grammar may implement whatever precedence and associativity rules you like, as long as it generates the same language and is unambiguous.)

$$S ::= SS \mid S + S \mid x$$

3. [10 pts] What loop invariant allows you to prove the postcondition for the following?

```
{ true }
A := 0;
C := N;
while C > A + 1 loop
  B := (A + C) / 2;
  if B * B <= N then
    A := B;
  else
    C := B;
  end if;
end loop;
{A ≤ √N and √N < A + 1}
```

4. [10 pts] Describe an advantage of dynamic typing (as used in Smalltalk) over static typing (as in Ada or Java).
5. [10 pts] Why would a language opt to use dynamic scoping (as Postscript and some old versions of Lisp do) rather than static scoping (as with nearly all other languages)?

6. [10 pts] Both C++ and Java allow a programmer to use a class name as a parameter to a generic class. Neglecting syntax and other usage rules, distinguish how the language have a different underlying implementation of such generics.

7. [10 pts] Suppose we are writing a Complex class in Smalltalk for representing complex numbers. The class already includes a “re:im:” class method that returns a newly created Complex instance with the given the real and imaginary components, as well as two unary instance methods “re” and “im” that return the real and imaginary components respectively.

Write a definition of the binary “*” instance method for multiplying two complex numbers, keeping in mind the definition of complex multiplication, $(a + bi)(c + di) = (ac - bd) + (ad + bc)i$. You should use a minimum of parentheses (or nearly so).

8. [10 pts] What is the function of the concept of *metaclass* that appears in Smalltalk?

9. [10 pts] Define what is meant by a *virtual method* in an object-oriented language.

10. [10 pts] Describe a disadvantage of multiple inheritance (as is found in Eiffel and C++) that leads other language designers to choose single inheritance (e.g., Java, C#).