Principles of Programming Languages - Midterm

K. Subramani
LDCSEE,
West Virginia University,
Morgantown, WV
{ksmani@csee.wvu.edu}

1 Instructions

(a) The midterm is to be turned in by $12:10$ pm.

(b) Each question is worth 4 points.

(c) Attempt as many questions as you can; you will be given partial credit.

2 Problems

1. **Language Design Principles:** Using the various languages discussed in class, explain the following concepts:
   (i) Generality.
   (ii) Uniformity.
   (iii) Extensibility.
   (iv) Restrictability.
2. **CFG Design:**
   (i) A palindrome is a word that reads the same forward and backward; for instance, "noon" is a palindrome over the English alphabet. Consider the alphabet $\Sigma = \{0, 1\}$. Design a CFG that represents the set of palindromes over Σ. (2 points.)
   (ii) Let $\Sigma = \{0, 1\}$ denote an alphabet. Design a CFG that represents the set of all strings that contain at least one pair of consecutive 0s in them. (2 points.)
3. **CFG Ambiguity:**
   (i) When is a CFG G said to be ambiguous? When is a language said to be inherently ambiguous? (2 points.)
   (ii) Let $G = \langle V, T, P, S\rangle$ denote a CFG, with $V = \{S\}$, $T = \{a, b\}$, and production rules P given by:
   $$S \rightarrow aSbS \mid bSaS \mid \epsilon$$
   Is G ambiguous? Justify your answer with a proof or counterexample. (2 points.)
4. **Semantics:** Enumerate the differences between:
   (i) Lexical and dynamic scoping. (1 point.)
   (ii) Static and dynamic Type checking. (1 point.)

   Is it possible to define the semantics for a language that is dynamically scoped but statically type checked? Justify your answer. (2 points.)

5. **Type Theory:** Consider the following block of **C** code:

```
struct A
   {
     int i;
     char j;
    };

 struct B
    {
      int i;
      char j;
     };

struct A x, *p;
struct B y, *q;
```

Which of the following statements lead to static errors? Explain.

(i) `x = y;`

(ii) `x = (struct A) y;`

(iii) `p = q;`

(iv) `p = (struct A*) q;`