

University of Toronto Mississauga  
Department of Mathematical and Computational Sciences  
CSC 324 — Principles of Programming Languages, Spring 2009

## Midterm Test

Name:

Student Number:

Note: Closed book. 50 minutes. 6 pages. 4 questions. 48 marks. All Scheme and ML programs should be written in good functional-programming style. Write all answers on the test booklet, using the back of pages if necessary. Good luck!

**If you do not know the answer to a question, and you write “I don’t know”, you will receive 20% of the marks of that question. If you just leave a question blank with no such statement, you get 0 marks for that question.**

1. (12 marks) Define a scheme function (`maxPos E`) that takes a nested list `E` as input and returns the largest positive number mentioned in `E`. If `E` contains no positive numbers, then return 0. For example,

`(maxPos '(1 a -2 b c 3 4)) => 4`

`(maxPos '(1 (a -2) (b (c (7 5) ()))))) => 7`

`(maxPos 13) => 13`

`(maxPos '(a b c)) => 0`

`(maxPos '(a (-6 c))) => 0`

2. (12 marks total) Consider the following pair of Scheme functions:

```
(define (f X) (cond ((null? X) X)
                    (else (g (f (cdr X)) (cons (car X) '())))))
```

```
(define (g X Y) (cond ((null? X) Y)
                      (else (cons (car X) (g (cdr X) Y)))))
```

(a) (5 marks) In ten words or less, describe what **g** does.  
(Only the first ten words of your answer will be graded.)

(b) (1 mark) Give an example of what **g** does.

(c) (5 marks) In ten words or less, describe what **f** does.  
(Only the first ten words of your answer will be graded.)

(d) (1 mark) Give an example of what **f** does.

3. (12 marks total)

(a) (8 marks) What is the type of each of the following ML functions (2 marks each):

```
fun f1(X,Y,Z) = (1+X+Y,Z);
```

```
fun f2 [] = []  
  | f2((X,Y)::L) = (Y,X)::f2(L);
```

```
fun f3(g,X,h,Y) = h(X,g(Y));
```

```
fun f4(f,g,h) = (fn X => h(g(f X)));
```

(b) (2 marks) In 25 words or less, describe what `f2` does. (Only the first 25 words of your answer will be graded.) Give an example to illustrate.

(c) (2 marks) In ten words or less, describe what `f4` does.  
(Only the first ten words of your answer will be graded).

4. (12 marks total)

(a) (2 marks) Define `employee` to be a named type for records, where each record has four fields: `id`, `name`, `age`, `salary`. These four fields contain an integer, a string, an integer, and a real number, respectively.

(b) (10 marks) Define an ML function `avgSal(L)` that takes a list `L` of employee records, and returns the average salary of the employees. If `L` is empty, then return a negative number. For full marks, you should use pattern matching whenever possible.