Midterm Examination

CMPUT 325, B2

Feb. 13, 1997

INSTRUCTIONS: (1) The time for this exam is 80 minutes; (2) This is an open book, open notes exam; (3) Please write your name and ID on the cover page of the exam booklet; (4) Please write legibly.

1. (12 points) A = (f (x y) (+ (* x y) (- y x))) and B = (s (y) (* y 2)). Please show the machine level representations of the following expressions.
   1.1. (4 points) A
   1.2. (4 points) (cons B nil)
   1.3. (4 points) (append (list 'A) (list 'B))

2. (20 points) Please reduce the following λ-expressions to their normal forms. Show all of your reduction steps.
   2.1. (10 points) $(\lambda xy|y)(\lambda x|xx)(\lambda x|yx)a$
   2.2. (10 points) $(\lambda yz|y)((\lambda xy|x)n)((\lambda x|xx)(\lambda x|xx))$

3. (16 points) Consider the following Lisp program:

```
(defun f (a)
   (if (or (null a) (atom a))
       a
       (if (atom (car a))
           (append (f (cdr a)) (list (car a)))
           (cons (f (car a)) (f (cdr a)))))
)
```

What will be returned after executing the following expressions?
   3.1. (8 points) (f '(a b (c)))
   3.2. (8 points) (f '(a (b c) d))

4. (12 points) Consider the above Lisp program again. Suppose the result of executing (- (caar (f X)) (cadr (f X))) is 1, please give a possible value for X.

5. (10 points) Please explain the special purpose of the following λ function. Give an example to support your explanation.
   $(\lambda y|(\lambda x|y(xx))(\lambda x|y(xx)))$

6. (15 points) Define a Lisp function which takes list A as its argument, and returns a list only containing the atom-elements in A. For example, if A = (a (b) c (d e)), (a c) will be returned. (You can use any Lisp functions allowed in the assignments.)

7. (15 points) Define a λ function, Succ2, which returns the number next to the successor of its argument. For example, (Succ2 2)$\rightarrow$4, (Succ2 3)$\rightarrow$5 ... Please use an example to verify your definition.

– Have a happy reading week!