CSE 428, Spring 1998

Midterm #2

6 April 1998

The exam consists of 5 exercises, totalling 80 points. Write your answers directly on these pages. **Please write your name and SSN at the top of the sheet!**

Exercise 1 (9 pts)

Consider the following datatype declaration for defining binary trees:

```
datatype 'a btree = emptybt | consbt of 'a * ('a btree) * ('a btree)
```

1. Consider the two following declarations of a function f:

   - `fun f (consbt (x,t1,t2)) = e1 | f emptybt = e2`
   - `fun f t = if t = (consbt(x,t1,t2)) then e1 else e2`

   Are these declarations equivalent?

   (a) Yes, always
   (b) No, never
   (c) It depends on the expressions `e1` and `e2`

2. Consider the two following declarations of a function g:

   - `fun g t1 t2 = e`
   - `val rec g = fn t1 => fn t2 => e`

   Are these declarations equivalent?

   (a) Yes, always
   (b) No, never
   (c) It depends on the expression `e`

Exercise 2 (20 pts)

Consider the datatype declaration of previous exercise. Define a function

```
nodes_which_satisfy :  ('a -> bool) -> ('a btree) -> ('a list)
```

which, given a property `p:'a -> bool` and a binary tree `t:'a btree`, it returns the list of nodes in `t` which satisfy `p` (doesn't matter in which order).

Exercise 3 (20 pts)

Define a function

```
merge :  (int list) -> (int list) -> (int list)
```

which, given two *ordered* lists of integers `l1` and `l2`, returns an *ordered* list `l3` which contains all the elements of `l1` and `l2` (possibly repeated).

Exercise 4 (10 pts)

Define a function

```
compose :  ('a -> 'b) -> ('b -> 'c) -> ('c -> 'd) -> ('a -> 'd)
```

which, given three functions f, g, and h, it returns their functional composition, i.e. the function ϕ such that for every x, $\phi(x) = h(g(f(x)))$.

Exercise 5 (21 pts)

For each of the following functions, write its most general type.

1. `fn f => fn x => fn y => f x y`

2. `fn f => fn (x,y) => f (x,y)`

3. `fn f => fn x => fn y => (f x, f y)`