Declarative Programming, Midterm exam, 19th May 2006
Total time available: 90 minutes, total score: 60
Standard ML, Group „A” (30 point)

When the task is to write a function, all standard functions of SML and the functions defined in the lectures can be used. The types of the standard functions which appear in the tasks are the following:

```
List.filter  : ('a -> bool) -> 'a list -> 'a list
map          : ('a -> 'b) -> 'a list -> 'b list
foldr        : ('a * 'b -> 'b) -> 'b -> 'a list -> 'b
op@          : 'a list * 'a list -> 'a list
op::         : 'a * 'a list -> 'a list
op o         : ('a -> 'b) * ('c -> 'a) -> 'c -> 'b
op^          : string * string -> string
```

```
explode      : string -> char list
str          : char -> string
ord          : char -> int
chr          : int -> char
Char.isUpper : char -> bool
rev          : 'a list -> 'a list
not          : bool -> bool
```

5. There are exactly two semantic errors in each of the following (independent) syntactically correct SML expressions. Which are these errors? (7 points)

   (a) `(#"a"::#"b" = explode "ab", (1, 2) < (2, 1), 1 < 2 < 3)`

   (b) `[3+3, chr 93.0, 7] = [3*2, ord #"b", 0-3-4, 0]`

   (c) `map (op +) [65, 6+5, ord chr 65]`

6. What is the value of `x` after evaluating the following (independent) value-definitions? (7 points)

   (a) `val (_::_::_::x) = rev(explode "PL" @ [#"S", #"M", #"L"])`

   (b) `val (_::x::_) = List.filter (not o Char.isUpper) (explode "aBcDeF")`

   (c) `val x = #1(foldr (fn (x, (y, b)) => (x+y, b andalso x < y)) (0, true) [3,2,1])`

7. Assume the following function definitions. (7 points)

```
(* val f1 = fn : string list * string list -> string list -> string list
   val f2 = fn : string list * string list -> string list *)
fun f1 (m::ms, n::ns) rs = f1 (ms, ns) (m^n::rs)
  | f1 _ rs = rs
and f2 msns = f1 msns []
```

   (a) Show the evaluation steps of `f2 (["SM","Pro"],["L","log"])`, using the substitutuon model and eager evaluation!

   (b) What is the value of `x` after evaluating the following (independent) value-definitions?

      i. `x = f2 ([],[])`
      ii. `x = f2 (["a","b"],["c"])`
      iii. `x = f1 (["L"],["I","J"]) ["SP"]`
      iv. `x = f1 (["Er"],["la","nguage"]) (f2 (["n"],["g"]))`

8. Assume the following exception-declaration:

```
exception notfound;
```

   A word (`char list`) is called a TLA (Three Letter Abbreviation), if it consists of 3 capital letters. Write an SML function called `firstTLA` which returns the first TLA found in its argument of type `char list list`, and throws a `notfound` exception, if the list doesn't contain TLA's. You may define auxiliary functions only with appropriate head-comment! (9 points)

```
(* firstTLA : char list list -> char list
   firstTLA l = the first TLA found in l *)
*)
```

   Examples:
```
firstTLA [] -> ! Uncaught exception: notfound
firstTLA [[#"a"]] -> ! Uncaught exception: notfound
firstTLA [[#"a"],[#"A",#"B",#"C"]] = [#"A", #"B", #"C"]
firstTLA (map explode ["LISP","SML","Prolog"]) = [#"S", #"M", #"L"]
```