

Student Name: _____

Design of Programming Languages - Fall 2001

First Exam

October 4, 2001

Points: 1._____2._____3._____4._____5._____6._____

Do any 5.

1. (10 pts) Records.
(4 pts) Define the type `student` to be an abbreviation for a record structure with fields `ID` of type `int`, `name` of type `string` and `courses` of type `string list`.
(6 pts) Write a function that, given a name and a list of students, returns a list containing all those records with the given name. You should assume that more than one student can have the same name.
2. (10 pts) Curried Functions.
Write a function `filter` that takes a predicate `P` as argument and produces a function that takes a list of elements of suitable type and returns those elements on the list that satisfy `P`.
3. (10 pts) Case Expressions.
A year is a leap year if and only if it is divisible by 4, but not by 100, unless it is also divisible by 400. Write an ML function `leapYear` of type `int → bool` that tells whether a given year is a leap year. Use a `case` expression in its body.

4. (10 pts) Polymorphism.

Given the functions

```
fun f(nil) = nil
|   f([x]) = [x]
|   f(x::y::zs) = [x, y];

fun g(x, y) = (f(x), f(y));

fun h(x, y) =
  let val v = f(nil) in (x::v, y::v) end;
```

For each of the expressions below, indicate whether it is legal, and, if not, what is the error?

- (a) `g([1,2,3], "a");`
 - (b) `g([1,2,3], nil);`
 - (c) `g([f,f], 1);`
 - (d) `g([1], [1,0]);`
 - (e) `h(1,2)`
 - (f) `h(1, "a");`
 - (g) `h(nil, nil);`
 - (h) `h([1], nil);`
5. (10 pts) Grammars.
Give a BNF definition (do not use extended BNF) of a language of balanced brackets. The alphabet is $\Sigma = \{[,]\}$.
6. (10 pts) Grammars.
Consider the context-free grammar generating strings of binary digits:

$$p : B \rightarrow D$$

$$q : B \rightarrow BD$$

$$r : D \rightarrow 0$$

$$s : D \rightarrow 1$$

Design an attribute grammar for this set of productions to define the value of a binary string of digits.

Hint: how do you evaluate a number whose decimal digits you read left-to-right?