Name _____

Student number _____

CS 2SC3 and SE 2S03 Fall 2008

Midterm Test Answer Key

Instructor: William M. Farmer

You have 50 minutes to complete this test consisting of 7 pages and 22 questions. You may use your notes and textbooks, but you may not use any calculators or other electronic devices. Answers to the first eighteen questions (1–18) are to be marked on the OMR scan sheet. Answer the last four questions (19–22) in the space provided on the exam. Do **NOT** use correction fluid on the exam or on the OMR scan sheet. An answer key will be posted on the course Web site. Good luck!

OMR Examination Instructions

NOTE: IT IS YOUR RESPONSIBILITY TO ENSURE THAT THE ANSWER SHEET IS PROPERLY COMPLETED: YOUR EXAMINATION RESULT DEPENDS UPON PROPER ATTENTION TO THESE INSTRUCTIONS.

The scanner, which reads the sheets, senses the shaded areas by their nonreflection of light. A heavy mark must be made, completely filling the circular bubble, with an HB pencil. Marks made with a pen or felt-tip marker will **NOT** be sensed. Erasures must be thorough or the scanner may still sense a mark. Do **NOT** use correction fluid on the scan sheet. Do **NOT** put any unnecessary marks or writing on the sheet.

(1) Print your name, student number, course name, section number, and the date in the space provided at the top of SIDE 1 (red side) of the form. The sheet **MUST** be signed in the space marked SIGNATURE.

(2) Mark your student number in the space provided on the sheet on SIDE 1 and **fill in the corresponding bubbles underneath**.

(3) Mark only **ONE** choice from the alternatives (A,B,C,D,E or 1,2,3,4,5) provided for each question. For a True/False question, enter a response of A or 1 for True and B or 2 for False. The question number is to the left of the bubbles. Make sure that the number of the question of the scan sheet is the same as the question number on the exam.

(4) Pay particular attention to the Marking Directions on the form.

(5) Begin answering questions using the first set of bubbles, marked "1".

Test continues on next page.

(1) [3 pts.] The semicolon (;) is used as a statement separator in both C and OCaml. Is this statement true or false?

(a) True.
(b) [False.]

(2) [3 pts.] The lambda expression

$$\lambda\, x : \mathbf{R} \,.\, \lambda\, y : \mathbf{R} \,.\, x + y$$

represents addition as a function on pairs of real numbers. Is this statement true or false?

(a) True.
(b) [False.]

(3) [3 pts.] In OCaml, a variable of type `int` is effectively a constant. Is this statement true or false?

(a) [True.]
(b) False.

(4) [3 pts.] According to the Principle of Least Privilege, immutable data structures should be avoided if possible. Is this statement true or false?

(a) True.
(b) [False.]

(5) [3 pts.] In C, a reference is created every time a variable is declared. Is this statement true or false?

(a) [True.]
(b) False.

(6) [3 pts.] In a programming language that supports exceptions such as OCaml, every exception that is raised during the execution of a program is caught exactly once. Is this statement true or false?

(a) True.
(b) [False.]

(7) [3 pts.] In OCaml, expressions of type _____ are used as statements.

(a) `bool`.
(b) `stmt`.
(c) [`unit`.]
(d) `void`.

Test continues on next page.

(8) [3 pts.] In both C and OCaml, the name of a variable is determined at

(a) Design time.
(b) Compile time.
(c) Run time.
(d) None of the above.

(9) [3 pts.] Which language is older than C?

(a) Lisp.
(b) Fortran.
(c) Cobol.
(d) All of the above.

(10) [3 pts.] An implementation of the C programming language usually supports

(a) Compilation to native machine code.
(b) Compilation to bytecode.
(c) Interpretation.
(d) All of the above.

(11) [3 pts.] Which values in OCaml cannot be physically modified?

(a) Lists.
(b) Vectors.
(c) References.
(d) Strings.

(12) [3 pts.] Which statement is *not* true about recursion?

(a) Recursion is a method of definition.
(b) Recursion can be used instead of loops.
(c) Recursion is supported by both C and OCaml.
(d) The use of recursion tends to make code longer and more difficult to understand.

(13) [3 pts.] In the pure functional programming paradigm,

(a) Procedures do not have side effects.
(b) Data structures do not have mutators.
(c) The block control structure is not used.
(d) All of the above.

Test continues on next page.

(14) [3 pts.] What OCaml operator corresponds to the C operator `&`?

(a) `!`.
(b) `loc`.
(c) `address`.
(d) None of the above.

(15) [3 pts.] Mutators are potentially a threat to the _____ of the values held by a data structure.

(a) Privacy.
(b) Integrity.
(c) Availability.
(d) All of the above.

(16) [3 pts.] Which level of language is usually the best general-purpose programming language?

(a) Machine language.
(b) Low-level like assembly language.
(c) Intermediate-level language like C.
(d) High-level language like OCaml.

(17) [3 pts.] Which execution mode usually executes code the fastest?

(a) Compilation to native machine code.
(b) Compilation to bytecode.
(c) Interpretation.
(d) Prolog.

(18) [3 pts.] A function prototype in C is like a _____ in OCaml.

(a) Function definition.
(b) Function type.
(c) Function body.
(d) Function application.

(19) [6 pts.] Briefly explain the difference between a type of machine integers and a type of bignums.

Answer: A type of machine integers is a *finite* set of integers, while a type of bignums is the complete *infinite* set of integers. Machine integers are usually represented in a single machine word. Operations on machine integers are thus very fast, but overflow errors are possible. Bignums are represented by using a potentially infinite amount of space. Operations on bignums are not as fast as on machine integers, but overflow is not an issue.

(20) [10 pts.] Suppose the following types are declared in OCaml:

```
type sample_tuple = (int ref) * (float ref) ;;
type sample_record = {x : int; y : float} ;;
```

Write a function

```
g : sample_tuple -> sample_record
```

that, given a tuple t of type `sample_tuple` as input, returns a record r of type `sample_record` such that t and r represent the same pair of values.

Answer:

```
let g t =
  {x = !(fst t); y = !(snd t)} ;;
```

(21) [15 pts.] Write a function in C that, using a for loop, implements the unary function

$$h : \mathbf{Z} \to \mathbf{Z}$$

specified by the following table:

condition	$h(n) =$
$n < 0$	0
$n \geq 0$	$\sum_{i=0}^{n}(2i+1)$

Answer:

```
int h(int n) {
  if (n < 0)
    return 0;
  else {
    int count = 0;
    int i;
    for (i = 0; i <= n; i++)
      count = count + (2 * i + 1);
    return count;
  }
}
```

(22) [15 pts.] Suppose an abstract data type of stacks implemented in OCaml includes the type `stack` and the following operators:

```
bottom : unit -> stack
height : stack -> int
top : stack -> float
push : float -> stack -> unit
pop : stack -> unit
```

Using a while loop and these operators, write a function

```
zeros : stack -> int
```

that, given a stack as input, returns the number of 0s (of type `float`) on the stack. It is permissible to alter the stack in the process of counting the 0s.

Answer:

```
let zeros s =
  let count = ref 0 in
  while not (height s = 0) do
    if top s = 0.
    then count := !count + 1 ;
    pop s
  done ;
  !count ;;
```

Test ends here. **7/7**