$Id: cmps112-2011q2-exam2.mm,v 1.53 2011-05-17 14:12:09-07 - - $

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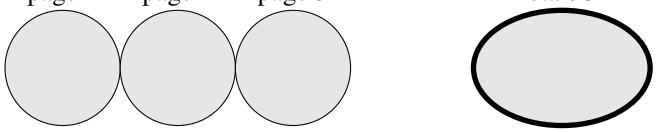

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No books ; No calculator ; No computer ; No email ; No internet ; No notes ; No phone. Neatness counts ! Do your scratch work elsewhere and enter only your final answer into the spaces provided.

1. Some fragmentary examples of polymorphism are given in each entry in the following table. Identify the general category by writing ***universal*** or ***ad hoc*** beside each. Further identify them with one of the terms ***conversion*** ; ***generic*** ; ***inclusion*** ; or ***overloading***. **[2✔]**

`let rec len = function`
`  | [] -> 0`
`  | _::cdr -> 1 + len cdr`
	`template <typename item_t>`
	`class stack { };`
	`stack<int> si;`

`class foo {`
`  foo () {}`
`  foo (int a) {}`
	`double sqrt (double);`
	`n = sqrt (6);`

2. ***Scheme :*** Define a function that will return the largest number in a list of numbers. Return `'undef` if the list is empty. The function `max` will return the largest of its arguments. You must either use an inner tail-recursive function, or correctly use `apply`. **[2✔]**

```
(define (maxlist list)
```

3. ***Scheme :*** Define a function to reverse a list. Your solution must be tail-recursive. Hint : You will need an internal helper function. **[3✔]**

```
(define (rev list)
```

4. ***Smalltalk :*** Assuming a class `Complex` has instance fields `real` and `imag`, and methods of the same name that may be used to enquire of another object, define two methods :

   (a) `real:imag:` will replace the real and imaginary fields of the receiver. **[1✔]**

   (b) The binary message `+` will return a new object with the sum of the reciever and its argument. (Add the real fields, add the imaginary fields.) Assume a class method `real:imag:`. **[2✔]**

5. ***Ocaml :*** Define a function **`contains`** which accepts a predicate and a list and returns true if the predicate is true for some element in the list. **[2✔]**

```
# contains ((=)3) [1;2;3;4];;
- : bool = true
# contains ((<)9) [1;2;3;4];;
- : bool = false
```

6. ***Ocaml :*** Define a function **`merge`** whose arguments are a binary predicate returning a relative ordering and two lists that are assumed sorted. Return a merged with combining the two lists into a single sorted list. **[3✔]**

```
# merge (<=) [1;5;7;9] [2;4;6;88];;
- : int list = [1; 2; 4; 5; 6; 7; 9; 88]
# merge (>) [9;5;3;1] [100;13];;
- : int list = [100; 13; 9; 5; 3; 1]
```

7. ***Ocaml :*** Define a function **`zip`** which takes two lists and returns a list of tuples, pairing each corresponding element. If the lists are of different lengths, ignore excess elements in the longer list. **[2✔]**

```
# zip [1;2;3] ['a';'b';'c';'d'];;
- : (int * char) list = [(1, 'a'); (2, 'b'); (3, 'c')]
```

8. ***Ocaml :*** Define a function **`unzip`** which takes a list of tuples and returns a tuple of lists, the first list containing the first item in each tuple, and the second list, the second item. **[3✔]**

```
# let l1, l2 = unzip [(1, 'a'); (2, 'b'); (3, 'c')];;
val l1 : int list = [1; 2; 3]
val l2 : char list = ['a'; 'b'; 'c']
```

Multiple choice. To the ***left*** of each question, write the letter that indicates your answer. Write ***Z*** if you don't want to risk a wrong answer. Wrong answers are worth negative points. **[11✔]**

number of correct answers		× 1 =	$= a$
number of wrong answers		× ½ =	$= b$
number of missing answers		× 0 =	0
column total $c = \max(a - b, 0)$	11		$= c$

1. Lazy evaluation of functions is the default in which language ?
   (A) Fortran
   (B) Haskell
   (C) Ocaml
   (D) Scheme

2. In Smalltalk, $\sqrt{2}$ can be computed with the following expression :
   (A) `(sqrt 2)`
   (B) `2 sqrt`
   (C) `sqrt (2)`
   (D) `sqrt 2.0;;`

3. In Smalltalk, an expression to which the `value` message may be sent in order to retrieve the value `9` is :
   (A) `(4 + 5)`
   (B) `<4 + 5>`
   (C) `[4 + 5]`
   (D) `{4 + 5}`

4. In a language with garbage collection, where the function `free` is unavailable, which of the following is impossible ?
   (A) dangling pointers
   (B) memory leak
   (C) null pointer exception
   (D) segmentation fault

5. A function which accepts a unit value, a function, and a list, and which produces a single value in an eager language using $O(1)$ stack space is :
   (A) `filter`
   (B) `fold_left`
   (C) `fold_right`
   (D) `map`

6. What is the type of the Ocaml expression
   ```
   map ((+)3)
   ```
   (A) `('a -> 'b) -> 'a list -> 'b list`
   (B) `int list -> (int -> int) list`
   (C) `int list -> int list`
   (D) `int list`

7. How would the first element (the element with the smallest subscript) of a Smalltalk array be set ?
   (A) `(set! a 1 6).`
   (B) `a at:1 put:6.`
   (C) `a put:6 at:1.`
   (D) `a[1] := 6.`

8. What is the value of
   ```
   (cdr (car (cons '(1 2 3) '(4 5 6))))
   ```
   (A) `((1 2 3) 4 5 6)`
   (B) `(1 2 3)`
   (C) `(2 3)`
   (D) `(cons '(1 2 3) '(4 5 6))`

9. The Ocaml function `List.tl` functions like `cdr` in Scheme. Its type is :
   (A) `'a list -> 'a`
   (B) `'a list -> 'a list -> 'a list`
   (C) `'a list -> 'a list`
   (D) `'a list -> int`

10. The style of programming in Smalltalk is :
    (A) functional
    (B) imperative
    (C) logic
    (D) object-oriented

11. Smalltalk was originally designed at :
    (A) Bell Labs
    (B) INRIA
    (C) MIT AI Lab
    (D) Xerox PARC

The Antikythera mechanism, built ca. 150–100 BCE, is the oldest known complex scientific calculator, and is sometimes called the first known analog computer, with operational instructions written in Greek. http://en.wikipedia.org/wiki/Antikythera_mechanism