OLLSCOIL NA hÉIREANN, CORCAIGH
THE NATIONAL UNIVERSITY OF IRELAND, CORK

COLÁISTE NA hOLLSCOILE, CORCAIGH
UNIVERSITY COLLEGE, CORK

SUMMER EXAMINATIONS 2012

Fourth Science — Computer Science

CS 4620 : Functional Programming I

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Professor James Bowen
Dr Joseph Manning

Answer all questions

$1\frac{1}{2}$ Hours

(*30%*) 1. Write definitions for each of the following Haskell functions, and state their types:

a) `allEqual xs`
is every item in the list `xs` equal to every other such item?
(return `True` if `xs` has only 0 or 1 items) (*10%*)

b) `allDifferent xs`
is every item in the list `xs` different from every other such item?
(return `True` if `xs` has only 0 or 1 items) (*10%*)

c) `countMax xs`
the number of times that its maximum item occurs in the non-empty list `xs`;
this function should make only ***one*** *pass over the list* (*10%*)

(*35%*) 2. a) Consider the standard Haskell function `id`, defined by:

```
id x = x
```

State the (most general) type of `id`. (*5%*)

b) Consider the standard Haskell function `(.)`, defined by:

```
( f . g ) x = f ( g x )
```

State the (most general) type of `(.)`. (*5%*)

c) Consider the Haskell function `compose`, which takes a list of functions and returns their composition; for example:

```
compose [ \n -> n+1, \n -> 2*n ] 3  ⇒ 7
compose [ ] 3                       ⇒ 3
```

State the (most general) type of `compose`. (*5%*)

d) Write a *recursive* definition of `compose`, which does *not* use function `(.)`. (*10%*)

e) Write a *non-recursive* definition of `compose`, which *does* use function `(.)`. (*10%*)

(35%) 3. a) Consider the standard Haskell function `zipWith`, where:

```
zipWith f [x1, x2, ...] [y1, y2, ...]  ⇒  [f x1 y1, f x2 y2, ...]
```

The length of the output list is the smaller of the lengths of the two input lists; the output list is infinite if both input lists are.

Give a definition for `zipWith`, including its type. (11%)

b) Consider the Haskell definition:

```
mystery = 1 : zipWith (*) mystery [ 1 .. ]
```

Write down the value of the expression:

```
take 5 mystery
```

Then suggest a more meaningful name for `mystery` and state its type. (12%)

c) Recall that a *Pythagorean Triple* consists of a 3-tuple of positive integers x, y, z, with $x < y < z$ and $x^2 + y^2 = z^2$.

Consider the following attempt to define the infinite list of Pythagorean Triples:

```
[ (x, y, z) | x <- [1..], y <- [1..], z <- [1..],
              x < y, y < z, x*x + y*y == z*z ]
```

Explain why this attempt is incorrect, and write a correct version. (12%)