COMPSCI 1JC3 Sample Midterm Test 1
McMaster University

Day Class, **Version 1** Dr. W. M. Farmer

DURATION: 2 hours October 10, 2024

Please CLEARLY print:

NAME:

Student ID: | | | | | | | | | |

In an addition to this examination paper, you will be given two answer sheets for this test. This examination paper includes 12 pages and 30 questions. You are responsible for ensuring that your copy of the examination paper is complete. Bring any discrepancy to the attention of your invigilator.

The examination will be conducted in two stages:

First Stage: You have 90 minutes to answer the questions in the examination paper on the first answer sheet working **by yourself**. Getting any help in any form from your fellow students and anyone else will be treated as academic dishonesty. You must submit your first answer sheet to your invigilator by the end of the 90-minute period. Your performance on the answer sheet counts for 80% of the Midterm Test 1 mark. You may want to fill out the second answer sheet as you fill out the first leaving blank those questions that you want to work on during the second stage.

Second Stage: You have 30 minutes to answer the questions in the examination paper on the second answer sheet working **with the other students in the test room**. You may walk around the test room, but you may not leave the test room. You must submit your second answer sheet and your examination paper to your invigilator by the end of the 30-minute period. Your performance on the answer sheet counts for 20% of the Midterm Test 1 mark.

Special Instructions:

(1) It is your responsibility to ensure that the two answer sheets are properly completed. Your examination result depends upon proper attention to these instructions:

- A heavy mark must be made, completely filling the circular bubble, with an HB pencil.
- Print your name, student number, course name, course number and the date in the space provided on the top of Side 1 and **fill in the corresponding bubbles underneath**.
- **Fill in the bubble corresponding to your version number.**
- Mark only **ONE** choice from the alternatives (1, 2, 3, 4, 5 or A, B, C, D, E) provided for each question. If there is a True/False question, mark 1 (or A) for True, and 2 (or B) for False. The question number is to the left of the bubbles. Make sure that the number of the question on the scan sheet is the same as the number on the examination paper.

- Pay particular attention to the "Marking Directions" given on the scan sheet.
- Begin answering the questions using the first set of bubbles, marked "1." Answer all questions.

(2) The use of notes and textbooks is **not** permitted in both stages of the test.

(3) Calculators, computers, cell phones, and all other electronic devices are **not** to be utilized in both stages of the test.

(4) Read each question carefully.

(5) Try to allocate your time sensibly and divide it appropriately between the questions.

(6) Select the **best** answer for each question.

Question 1 [1 mark]
In all the major programming languages, a tail recursive function executes in a fixed amount of space like a loop does. Is this statement true or false?

A. True.

B. False.

Question 2 [1 mark]
The nonnegative rational numbers (i.e., the members of $\{x \in \mathbb{Q} \mid 0 \leq x\}$) with their standard ordering are Noetherian. Is this statement true or false?

A. True.

B. False.

Question 3 [1 mark]
A Haskell function `f` of type `a -> Bool` is a predicate but not a boolean function. Is this statement true or false?

A. True.

B. False.

Question 4 [1 mark]
Every boolean function can be defined using just `and` (`&&` in Haskell) and `or` (`||` in Haskell). Is this statement true or false?

A. True.

B. False.

Question 5 [**1 mark**]
For all expressions `a,b,c` in Haskell, if `(a,b,c)` is a tuple, then `[a,b,c]` is a list. Is this statement true or false?

A. True.

B. False.

Question 6 [**1 mark**]
To show that a recursive definition of a function makes sense, values that are well-ordered need to be assigned to the inputs of the function? Is this statement true or false?

A. True.

B. False.

Question 7 [**1 mark**]
The type of the Haskell function

```
ifThenElse a b c = if a then b else c
```

is

```
Bool -> Bool -> Bool -> Bool
```

Is this statement true or false?

A. True.

B. False.

Question 8 [**1 mark**]
The model of computation developed by Haskell Curry is known as the *lambda calculus*. Is this statement true or false?

A. True.

B. False.

Question 9 [**1 mark**]
Which Haskell type contains infinitely many values?

A. `Bool`.

B. `Double`

C. `Float`.

D. `Integer`.

Question 10 [**1 mark**]
In the context of the Haskell code

```
x :: Float
x = 32.48
```

what is the type of `[x, x - x]`?

A. `[Float]`.

B. `[Float, Int]`.

C. `[Float, Integer]`.

D. `[Float, Float]`.

Question 11 [**1 mark**]
What is strongly avoided in a pure functional programming language like Haskell?

A. Functions with side effects.

B. Code that changes the state of a program.

C. The modification of data.

D. All of the above.

Question 12 [**1 mark**]
Who first showed that Gottfried Leibniz' dream that all decision problems can be solved by computation is an impossibility?

A. Alonzo Church.

B. Kurt Gödel.

C. Stephen Kleene.

D. Emmy Noether.

Question 13 [1 mark]
Who first developed a systematic approach to solve linear and quadratic equations algebraically?

A. Mohammad Al-Khwarizmi.

B. George Boole.

C. Gottfried Leibniz.

D. Emmy Noether.

Question 14 [1 mark]
Who invented the first mechanical calculator that could do addition, subtraction, multiplication, and division?

A. Mohammad Al-Khwarizmi.

B. Alonzo Church.

C. Stephen Kleene.

D. Gottfried Leibniz.

Question 15 [1 mark]
Single-precision floating point numbers use 32 bits with 1 bit for the sign, 23 bits for the (unsigned) mantissa, and 8 bits for the (signed) exponent. How many single-precision floating point numbers are in the interval $[4, 8) = \{x \in \mathbb{Q} \mid 4 \leq x < 8\}$?

A. 2^{22}.

B. 2^{23}

C. 2^{25}

D. 2^{32}.

Question 16 [1 mark]
Let x be an 8-bit machine integer and y be the 8-bit machine integer obtained from x by inverting its bits. (So y is 11001010 if x is 00110101.) What is the value of y?

A. $-(x + 1)$.

B. $-x$.

C. $-(x - 1)$.

D. $-(x - 2)$.

Question 17 [**1 mark**]
In the two's complement representation of the integers using 8 bits, what number in base 10 represents the result of adding -126 and -127?

A. -125

B. -3.

C. 3.

D. 125.

Question 18 [**1 mark**]
Consider the following Haskell code:

```
w :: Float
x :: Float
y :: Float
z :: Float

w = -1/0
x = -0/0
y = 0/0
z = 1/0
```

What are the values of `w,x,y,z`?

A. `-Infinity`, `-Infinity`, `Infinity`, `Infinity`.

B. `-Infinity`, `NaN`, `NaN`, `Infinity`.

C. `-NaN`, `-NaN`, `NaN`, `NaN`.

D. `NaN`, `NaN`, `NaN`, `NaN`.

Question 19 [1 mark]
Consider the following Haskell code:

```
nand :: Bool -> Bool -> Bool
nand x y = not (x && y)
```

Which of the following Haskell functions implements the `and` (i.e., `&&`) function?

A. `f1 x y = (nand x y) || (nand x y)`.

B. `f2 x y = (nand x y) && (nand x y)`.

C. `f3 x y = nand (nand x x) (nand y y)`.

D. `f4 x y = nand (nand x y) (nand x y)`.

Question 20 [1 mark]
Which of the following Haskell function definitions is tail recursive?

A.
```
g1 x
   | x == 0 = 0
   | x /= 0 = if x > 0 then g1 (x - 1) else g1 (x + 1)
```

B.
```
g2 x
   | x == -1 = -1
   | x /= -1 = if x > -1 then g1 (x - 1) else -1 * (g2 (x + 1)
```

C.
```
g3 x
   | x == 2 = 2
   | x /= 2 = if x > 2 then 2 * g3 (x - 1)  else (g3 (x + 1))
```

D. All of the above.

Question 21 [**1 mark**]
Consider the following function:

```
guelph m n f
  | m > n   = 0
  | m <= n  = (guelph m (n - 1) f) + f n
```

What is the value of

```
guelph (-1) 4 (\x -> x^2)
```
?

A. 0.

B. 24.

C. 31.

D. 36.

Question 22 [**1 mark**]
Consider the following functions:

```
dundas x = x + 2

hamilton x = x^2

london f g = \x -> f (g x + x)
```

What is the value of

```
london dundas hamilton 3
```
?

A. 12.

B. 14.

C. 31.

D. 128.

Question 23 [**1 mark**]
Consider the following Haskell code:

```
windsor x
  | x == 0     = 0
  | otherwise = windsor (x - 1) + x

orillia n = [windsor m | m <- [1..n]]
```

What is the value of the expression

`orillia 5` ?

A. `[1,2,3,4,5]`.

B. `[1,3,6,10,15]`.

C. `[1,9,36,100,225]`.

D. `[6,7,8,9,10]`.

Question 24 [**1 mark**]
Which mode of program execution is best for learning a programming language and debugging code?

A. Compilation to byte code.

B. Compilation to native machine code.

C. Interpretation.

D. Execution done with pencil and paper.

Question 25 [**1 mark**]
Which of the following statements about floating point numbers is incorrect?

A. There are two floating point values that represent the number 0.

B. The density of the floating point values around a real number r decreases as r increases in absolute value.

C. Floating point numbers cannot represent irrational numbers.

D. In Haskell, the type `Double` of double-precision floating point numbers represents more rational numbers than the type `Rational`.

Question 26 [**1 mark**]
In Haskell, what is is the type of `2/3`?

A. `Float`.

B. `Double`

C. `Rational`.

D. `Fractional a => a`.

Question 27 [**1 mark**]
Which number in base ten can be represented exactly by a member of type `Float`?

A. 0.5250.

B. 0.5125.

C. 0.5375.

D. 0.5625.

Question 28 [**1 mark**]
What is the hexadecimal number ABC in decimal?

A. 2748.

B. 3021.

C. 6432.

D. 8461.

Question 29 [1 mark]
A *prime number* is a natural number greater than 1 whose only factors are 1 and itself. Consider the Haskell code

```
factors n = [m | m <- E1, n E2 m == 0]

isPrime n = factors n == E3

primes n = [p | p <- [1..n], isPrime p]
```

where E_1, E_2, and E_3 are unspecified expressions. What should these three expression be so that

```
primes 100
```

returns a list of the prime numbers less or equal to 100.

A. `[1..n-1]`, `` `mod` ``, `[n]`.

B. `[1..n]`, `` `div` ``, `[1]`.

C. `[1..n]`, `` `mod` ``, `[1,n]`.

D. `[2..n-1]`, `` `mod` ``, `[1,n]`.

Question 30 [1 mark]
Consider the boolean function `sarnia` specified by the following truth table:

a	b	c	sarnia a b c
F	F	F	T
F	F	T	F
F	T	F	F
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	F
T	T	T	F

Which of the following function definitions correctly implements `sarnia`?

A.
```
sarnia a b c =
    ((not a) || (not b) || (not c)) &&
    (a || (not b) || (not c)) &&
    (a || (not b) || c)
```

B.
```
sarnia a b c =
    ((not a) && (not b) && (not c)) ||
    (a && (not b) && (not c)) ||
    (a && (not b) && c)
```

C.
```
sarnia a b c =
    (a && b && c) ||
    ((not a) && b && c) ||
    ((not a) && b && (not c))
```

D.
```
sarnia a b c =
    ((not a) && (not b) && c) ||
    ((not a) && b && (not c)) ||
    ((not a) && b && c) ||
    (a && b && (not c)) ||
    (a && b && c)
```

Please bubble in your **student number** and **version number** on your scan sheet!

THE END.