MSc Primer course test

September 2013

Duration: 60 mins (75 mins allowed)

- Attempt ALL 10 questions on the paper.
- There are a varying number of marks for each question.
- Simplicity and clarity of expression in your answers is important.
- Electronic calculators are NOT permitted (or any other similar device).

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.

Name: (In BLOCK CAPITALS) __________________________________________

Contact Email: ______________________________________________________

<table>
<thead>
<tr>
<th>Question:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Marks:</td>
<td>12</td>
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<td>8</td>
<td>5</td>
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<td>20</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>
Question 1 ............................................................... Total: 12 marks

Write a simple algorithm in pseudo code (or Groovy) to compute the sum of a list of numbers.

The input to the algorithm is a list of numbers, L.
The output is the sum of these numbers.
For example, for the input $L = [3, 4, 5]$ the output should be 12. If $L$ is empty, the output should be 0.
Question 2 ......................................................... Total: 12 marks

When are the following expressions true (if ever)?

Where

\[ \text{AND} = \land \]
\[ \text{OR} = \lor \]
\[ \text{NOT} = \neg \]

(a) \[ A \land B \land (\neg C) \lor A \]

(b) \[ (A \lor (\neg C)) \lor (B \land (\neg C)) \]
\[(a \land \neg b \lor \neg c) \land \neg (b \land \neg d) \lor (a \lor \neg b)\]
Question 3 ......................................................... Total: 8 marks
What is the result of executing the following Groovy code? What function does it calculate? Explain your answer.

List l = [1,6,7,3,4,5,6,9]

Integer thing = 0

while (l != []){
    if (l.head() % 2 == 0)
        thing++
    l = l.tail()
}

println thing
Question 4 .......................................................... Total: 5 marks
Briefly describe the Java Virtual Machine (JVM)? You should include in your answer the relationship between the bytecode and the underlying “native” machine instructions.
The four digit number 2652 is such that any two consecutive digits from it make a multiple of 13. Another number N has this same property, is 100 digits long, and begins in a 9. What is the last digit of N?
What is the result of executing the following Groovy code? What function does it calculate? Explain your answer.

```groovy
List l = [2, 6, 1, 3, 5, 7, 8, 1]
Integer ls = l.size()
Integer v = 2
Integer m = ls / v
Integer result = 0

l.sort()
if (ls % v > 0) {
    result = l[m]
} else {
    result = (l[m-1] + l[m]) / v
}

println result
```
Question 7. ................................................................. Total: 20 marks

(a) Briefly explain the difference between binary, octal, and hexadecimal. 6 marks
You should provide appropriate examples to illustrate your answer.

(b) Convert the following: 12 marks
   i. \(10314_5 = (\cdots)_{10}\)
   ii. \(631_{10} = (\cdots)_8\)
   iii. \(11011001_2 = (\cdots)_8\)
   iv. \(C3B_{16} = (\cdots)_8\)
(c) How might one indicate the difference between a positive and negative number in a binary number representation?
Question 8 .......................... Total: 10 marks
Using the “box and arrow” representation we discussed in class provide memory diagrams for the following:

(a)  $[3, [4, [5, 6, 2], 5, [4, 5], [12]]]$

(b)  $[[73, 3], 4, [5, 62], [5, [4, 5]], 12]$

(c)  []
(a) Bob, Carol, Ted, and Alice each make the following statements:

Alice: I am telling the truth.
Bob: Alice is telling the truth.
Ted: Bob is telling the truth.
Carol: Ted is lying.

Only one of the four people is telling the truth. Which one? Explain your answer.

(b) They now make the following statements:

Alice: Bob is lying.
Bob: Ted is lying.
Ted: I like beer.
Carol: 2+2=4.

Now two of the four people are telling the truth. Which two? Explain your answer.
(c) They are now joined by Bruce. They each make the following statements:  
Alice: I like wine.  
Bob: Ted is lying.  
Ted: Alice is lying.  
Carol: Alice likes beer.  
Bruce: Alice likes beer.  
Now three of the five people are telling the truth. Which ones? Explain your answer.
Question 10 .......................................................... Total: 10 marks
Using the “box and arrow” representation we discussed in class what lists do the following represent:

(a) 

(b) 

(c)