Faculty of Science
Final Examination

Computer Science COMP-102B
Computers and Computing

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Date: April 23, 2008
Time: 9:00 – 12:00

INSTRUCTIONS:

This examination is worth 40% of your final grade.
The total of all questions is 100 points.
Each question is assigned a value found in brackets next to it.
O P E N • B O O K S •/• O P E N • N O T E S
Faculty standard calculator permitted only.
This examination consists of 4 pages including title page.
This examination consists of 7 questions.

SUGGESTION : read all the questions and their values before you start.

[25%] **1)**

a) Give the *netmask* (in format W.X.Y.Z) corresponding to the network address M.N.U.V/18 where M,N,U,V,W,X,Y and Z are integers < 256 ?

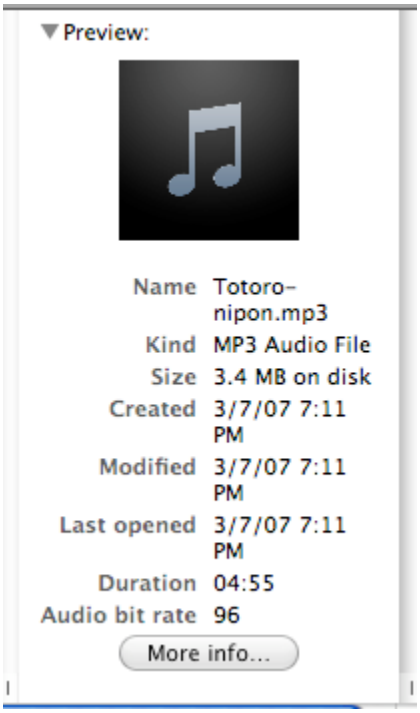
b) What number (expressed in base 10) has 64-bit floating point representation

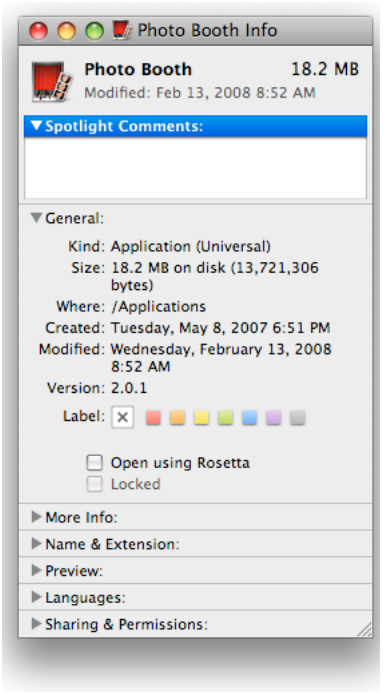
1 00101010101 0101001000000000000000000000000000000000000000000000 ?

c) What is the hexadecimal representation of the 64-bit sequence from **b)** ?

d) In the leftmost picture below, you can see the duration of a music file named "Totoro-Nipon.mp3" to be 4 minutes and 55 seconds. If this tune was stored in stereo AIFF format, how big would it be ? Also, give the ration of the sizes of the MP3 file over the AIFF file.

e) In the rightmost picture below, you see the size of application "Photo Booth" in bytes and MB. How come these two numbers look so different ?





[15%] **2)** Give an algorithm such that given two integers x,y it computes z such that $z_i = x_i \oplus y_i$, where "⊕" stands for exclusive-or, and the x_i, y_i, z_i are the binary representations of x,y,z.

[10%] **3)** Let A_k be a secret key authentication function. Assume Alice and Bob secretly share a random key k. When Alice wants to send an authenticated message (m) to Bob she computes $t=A_k(m)$ and transmits (m,t) to him. Upon reception, how does Bob (who also knows k) verify that the message is properly authenticated ? Explain how it is different in a Digital Signature Scheme.

[10%] **4)** For each statement, say if it is *true* or *false*. You may provide a short explanation.

Correct = +1 pt, Incorrect = -0.5 pt, No answer = 0 pt, Minimum Total= 0 pt.

(a) Deep Blue (IBM) is a combination of computer/program that will win at the game of chess 100% of the time.

(b) Animation movies (Bambi, Toy Stories, Shrek, etc) usually require less space than traditional movies (Star Wars, Laurence of Arabia, Wizard of Oz, etc) in MPEG2 DVD format.

(c) The big improvement in computer performances in the early 70's was due to miniaturization of vacuum tubes.

(d) In JAVAScript, the "+" sign is only for addition.

(e) The technique known as "Motion Capture" in computer graphics consists of imitating human motions using AI programs that analyze pictures of moving people.

(f) Robotic locomotion is mainly achieved through legs and wheels.

(g) The number of **Ethernet** addresses is larger than the number of **IP** addresses.

(h) The 7 layers of the OSI model must be strictly implemented to obtain a functional and reliable network.

(i) The words "upload" and "download" have similar meanings to "up stream" and "down stream" if we associate the data going into a computer to the flow of a river.

(j) For all Boolean values x,y we have, $x \oplus y = (x \wedge y) \vee (\neg x \wedge \neg y)$.

[10%] **5)** Consider the following JAVAScript examples

```
var variable = "top-level";
function LeftFunction() {
  var variable = "local";
  function LchildFunction() {
    print(variable);
  }
  LchildFunction();
}
LeftFunction();
```

```
var variable = "top-level";
function RightFunction() {
  var variable = "local";
  function RchildFunction() {
    var variable = "inner";
    print(variable);
  }
  RchildFunction();
}
RightFunction()
```

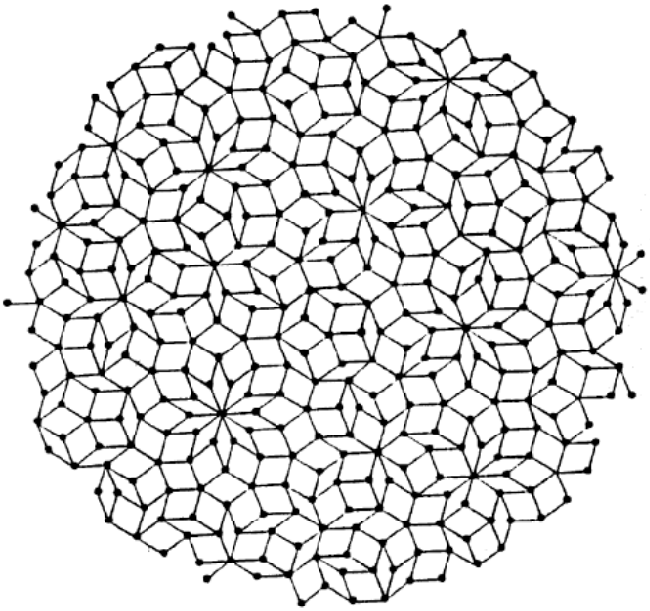
a) In each of these two examples above, what is going to be printed by the "`print(variable)`" statement ?

b) Explain the rules that define which instance of a variable is going to be used at the execution of a statement.

[10%] **6)** Give an analogy between cellular DNA and a computer program. Draw as many similarities as you can. Also explain how the *interpretation* of DNA and genes differ from the formal definition of an algorithm.

[20%] **7)** A **graph** is a set of vertices **V,** together with a set of edges **E**, made of pairs of vertices (u,v) such that u,v∈ **V**. We say that a graph **(V,E)** is k-colorable if there exists a labeling function (attaching a color to each vertex), **color** : **V** → {1,2,3,…,k}, such that

for all edge (u,v) ∈ **E** we have **color**(u)≠ **color**(v).



Consider the above graph (vertices are dots and edges are lines).

— Be careful, I mean the graph, not the map. —
— The map is 3- and 4-colorable, while not 1- or 2-colorable. —

a) Argue that the graph is **NOT** 1-colorable.

b) Argue that the graph is 4-colorable.

c) Argue in favor or disfavor of the 2-colorability of this graph.

d) Draw any small graph which is **NOT** 4-colorable.
Isn't this contradicting the 4-color theorem ? Explain.