

COMP102 Midterm Test
McGill University, Fall 2006

**Seat
Number**

Name: _____ SOLUTIONS _____

Student Number: _____

1. *History of Computation* [5 points]

What was one of the computational problems that motivated the development of computational machines? Why?

At some point, analyzing US population census data using human power alone became impossible. The need to process a lot of information quickly motivated the development of computational machines. Other computational problems that we discussed in class are computing logarithmic and trigonometric tables, performing the necessary computations for the making of the atom bomb, and generally performing heavy-duty arithmetic operations for scientific or statistical purposes. Note that a “computational problem” is a problem that requires computational power, not a problem with computational machines.

2. *Number Representation* [11 points]

(a) What is 30_{10} in binary? [3 points]

$$30/2 = 15 + 0/2$$

$$15/2 = 7 + 1/2$$

$$7/2 = 3 + 1/2$$

$$3/2 = 1 + 1/2$$

$$1/2 = 0 + 1/2$$

Reading the remainders from the bottom up, the binary equivalent of 30_{10} is 111110_2 .

(b) What is 255_{10} in binary? (Hint: you can answer this question quickly) [3 points]

Note that 256_{10} is 2^8 , or 10000000_2 . Thus 255 is the largest number that can be represented using 8 bits, or 1111111_2 . We have seen this number many times in class.

(c) Perform the following binary arithmetic operation [3 points]

$$10001_2 - 111_2$$

$$\begin{array}{r} *** \\ 10001 \\ - 111 \\ \hline 1010 \end{array}$$

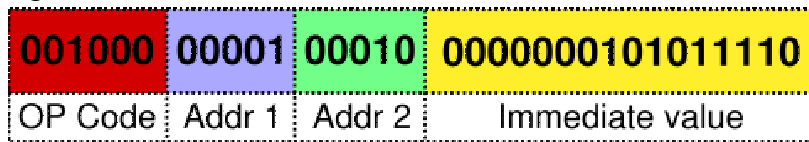
(d) What is the decimal equivalent of the hexadecimal number $1E_{16}$? [2 points]

$$E_{16} = 14_{10}$$

$$1E_{16} = 1 \times 16 + 14 = 30_{10}$$

3. *Computer Architecture* [9 points]

(a) Suppose that the Program Counter stores 001, which is the address of the following machine instruction:



The OP Code 001000 means that this is an “Add Immediate” instruction. This instruction says to add the contents of CPU register at Address 2 (Addr 2) and the Immediate Value and store the result in the CPU register at Address 1 (Addr 1). Describe the fetch-execute cycle with respect to this machine instruction. Note that nothing needs to be written to main memory after this instruction is executed. [5 points]

Read in the Program Counter the address 001 in main memory of the instruction to be processed next. Fetch the machine instruction contained in the address 001 in main memory. Decode this machine instruction: recognize that it is an Add Immediate instruction from the OP Code. Update the Program Counter to store the main memory address of the next instruction to execute after this instruction is executed. Give the ALU the contents of CPU register at Address 2 and the Immediate Value and tell it to add the two values. Store the result in the CPU register at Address 1.

(b) Explain 2 major differences between RAM and the hard disk as storage mediums. [4 points]

RAM is faster than Hard Disk because RAM allows random access to stored data, while the Hard Disk is sequential (within a sector). RAM is volatile; that is, all data is lost when electric power to the computer is cut. However, the Hard Disk is able to store data in a more permanent fashion because its contents are retained even after the electric power is cut off.

4. *Image File Formats* [11 points]

(a) If we were using colour depth 15, describe the colour represented by the following bit sequence: 11111111100000 [4 points]

Using the RGB scheme for colour representation (the only one we learned), the first 5 bits represent the amount of red, the next 5 bits the amount of green, and the last 5 bits the amount of blue. In this colour, there is an equal amount of red and green (namely, 11111), yet no blue. This colour appears yellow.

- (b) The .gif file format is an 8 bits-per-pixel image format. How many distinct colours can each pixel represent? In what case is this file format lossy? In what case is this file format lossless? [1 + 3 + 3 = 7]

$2^8=256$ distinct colours can be represented. This file format is lossy in case an image has more than 256 colours. This file format is lossless in case an image has at most 256 distinct colours.

Note that the question concerned this particular file format. It was not asking for a definition of a lossy/lossless file encryption.

5. *Computer Networks* [19 points]

- (a) Why does a TCP header contain the port number of the destination computer, but not the IP address? [3 points]

The IP address is contained in the IP header. The TCP header is contained in the IP data, so by the time we get to the TCP header, we know already the IP address of the destination computer.

- (b) UDP does not consider the sequence numbers of packets. Why does this make it a good protocol for watching a live broadcast of a sporting event over the Internet? [3 points]

Considering sequence numbers of packets presents a large computational overhead, possibly slowing down the broadcast as you are watching it. Furthermore, the sequence numbers are unnecessary in this case, because if one packet arrives out of order, you may not notice the effect.

- (c) You are browsing the Internet and want to go to www.google.ca/example.html. You will send an HTTP packet containing `GET /example.html HTTP/1.0`. How do you discover where to send your packet? List all steps. [5 points]

In order to send your packet, you need to know the IP address of the destination computer. To discover this IP address, you do:

1. Ask the root DNS server for the IP address of the .ca DNS
2. Ask the .ca DNS for the IP address of the google.ca DNS
3. Ask the google.ca DNS for the IP address of www.google.ca

Send your packet to this IP address.

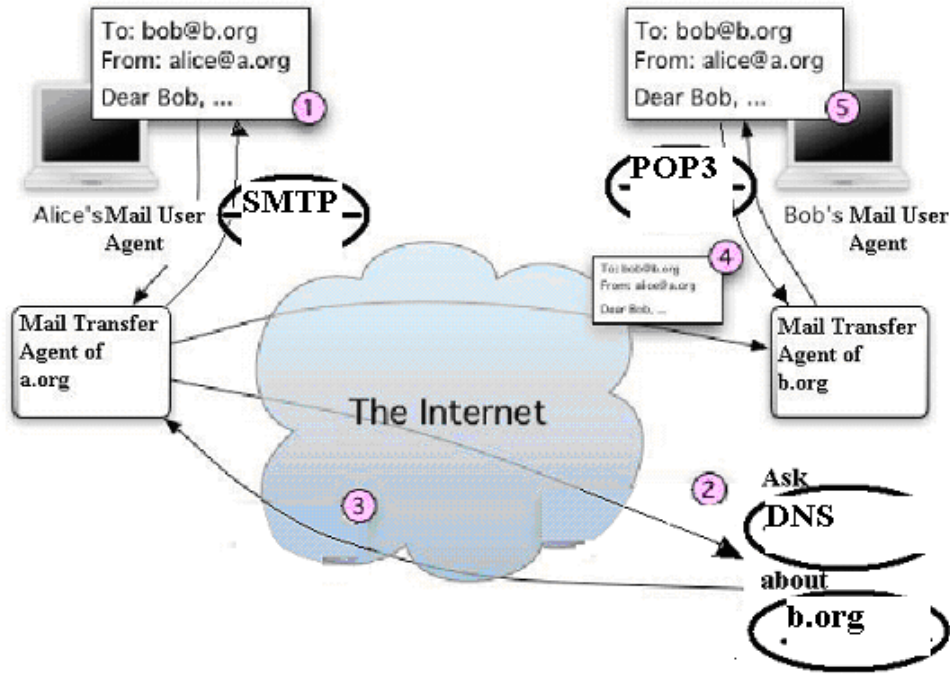
You may have also mentioned that you first check locally the DNS cache to see if anyone accessed any of the domains. Note that example.html is not part of the domain name.

- (d) List 2 major differences between Client-Server and Pure Peer-to-Peer network architecture. [4 points]

In a Client-Server architecture, all communication between computers has to be done through the central dedicated server. In a pure Peer-to-Peer network architecture, peers can act as both clients and a servers simultaneously. In a Client-Server setting, adding more client computers, but not servers, to the network will slow it down. In a Peer-to-Peer setting, adding peers will generally not affect network performance.

(e) Complete the 4 bold blanks (surrounded by ovals) in the following picture describing the process of sending an e-mail message from Alice to Bob. Choose the most logical term from the following list when filling the blanks: [4 points]

HTTP a.org POP3 HTML DNS b.org JXTA SMTP UDP IPv4 Alice Bob



Bonus Question: [5 points]

Is it possible to represent fractions and negative numbers in unary (base 1)? How or why not?

It is not possible to represent fractions in unary, because there needs to be special symbol to separate the numerator and the denominator. This symbols needs to be different from 1 to indicate the end of the numerator. Since unary uses only a single symbol, it is not possible to come up with such a symbol. It is not possible to represent negative numbers in unary because, because there is no symbol to represent the +/- sign or to separate this field from the rest.

Answers that argued that unary numbers can only represent whole, positive numbers because adding a digit will increase the value by 1 got most of the marks, but not all because I wanted you to think about the possibility of using the symbols to represent other concepts than numbers. In binary both are possible because of the possibility of giving symbols additional meaning than just numerical value.