# CS 199 LBP: Mid-Term 1

March 6, 2007

*There are 10 types of people in the world: Those who know binary, and those who do not.*

| Name: |
|---|

Instructions:

- Write your name in the box above.
- There are 20 questions on 8 pages. Each page is printed on only one side.
- There is no penalty for guessing.
- Every problem is worth one point except where otherwise indicated.

1. A computer uses electricity
   (a) to represent 0 and 1
   (b) to spin the disk
   (c) to help cool the cpu
   (d) all of the above

2. Hexadecimal is used because
   (a) binary has too few values
   (b) sixteen is a power of two
   (c) there are sixteen colors that need to be represented
   (d) sixteen is more than 10

3. What would the implications for computing be if a high-speed microscopic transistor with 10 stable states were invented?

4. (2 points) Which machine is likely to solve a problem more quickly, assuming all other things not mentioned are equal? Justify your answer with a short explanation.
   (a) A 2.0 GHz processor with 512Mb RAM, 240Gb HD, and 512Kb Cache
   (b) A 2.5 GHz processor with 256Mb RAM, 120Gb HD, and 2Mb Cache
   (c) A 3.0 GHz processor with 256Mb RAM, 100Gb HD, and 2Mb Cache
   (d) A 3.2 GHz processor with 128Mb RAM, 80Gb HD, and 512Kb Cache

5. While ASCII was introduced in 1963, Unicode did not become a standard until 1991. Can you explain why Unicode was not used earlier?

6. (2 points) Suppose the seek time of a disk is x and latency is y and the computer needs to access the disk 100 times during a particular computation.

   (i) How much time would you expect to be spent accessing the disk?

   (a) 100x + 100y
   (b) 100xy
   (c) 100 + x + y
   (d) x + 100y
   (e) 100x + y

   (ii) Suppose all of those accesses were in the same cylinder, then how much time would you expect to be spent accessing the disk?

   (a) 100x + 100y
   (b) 100xy
   (c) 100 + x + y
   (d) x + 100y
   (e) 100x + y

7. Two numbers to be added are stored on disk. They are then moved to main memory, and then to registers and added via machine instructions. Suppose the time to fetch the numbers from the disk is F, and the time to move them from main memory to registers and add them is A. The total time is then F+A. For most modern computers, approximately what percentage of this total time is F? Pick the closest answer.

   (a) 99.9
   (b) 99.0
   (c) 9.9
   (d) 0.99
   (e) 0.09
   (f) 0.009

8. (2 points) A ternary computer uses base 3 to represent numbers. It has the value 22012 stored in memory. What would this look like stored in a (base 2) computer memory?

9. (3 points) Each of the numerals 0,1,2 used in the ternary computer is called a "ternary digit", or "trit" for short.

   Let b(x) = the number of bits needed to store x distinct values using a binary (base 2) representation scheme. Let t(x) = the number of trits needed to store x values using a ternary (base 3) representation scheme.

   Sketch the graphs of b(x) and t(x) on the same coordinate axes, where the x axis represents the number of distinct items to represent, and the y axis represents the number of bits (or trits) needed to represent the x different items. To get you started, notice that b(6) = 3, because two bits can only represent 4 items, but 3 bits is enough to represent 8 (⟩ 6) items. Similarly, t(6) = 2, since two trits are enough to represent 9 items (00, 01, 02, 10, 11, 12, 20, 21, 22).

   In your graph, show values of x between 10 and 1000.

   *Bonus: By another name, what well-known functions approximate b(x) and t(x)?*

10. (3 points) A machine code instruction is 4 hexadecimal digits long. The first can be 1, 2, or 3, corresponding to LOAD, STORE, or ADD respectively. The machine we use has 16 registers, R0 through R15, so we can identify a particular register using a single hex digit. Also, the machine has 256 memory locations, M0 through M255.

A LOAD instruction copies a value from a memory location into a register (overwriting the previous contents of the register). The format of a LOAD instruction is:
1 ⟨ Register number, using 1 hex digit⟩ ⟨ Memory Location, using 2 hex digits⟩
For example, if we wanted to copy the value in Memory location B2 into register 7, the instruction would be 1 7 B 2

A STORE instruction copies a value from a register into a memory location (overwriting the previous contents of the location). The format of a LOAD instruction is:
2 ⟨ Register number, using 1 hex digit⟩ ⟨ Memory Location, using 2 hex digits⟩
For example, if we wanted to copy the value from register 15 into Memory location 8A, the instruction would be 2 F 8 A

An ADD instruction adds the contents of 2 registers and stores them in a another register (overwriting the previous contents of the destination register). The format of an ADD instruction is:
3 ⟨ destination register number⟩ ⟨ first source register⟩ ⟨ second source register⟩
For example, if we wanted to add the contents of registers 5 and 8, and store them in register 9, the instruction would be 3 9 5 8.

What are the contents of register 4 after this code is executed? Before the code is executed, memory locations 36 through 3A have the following values:

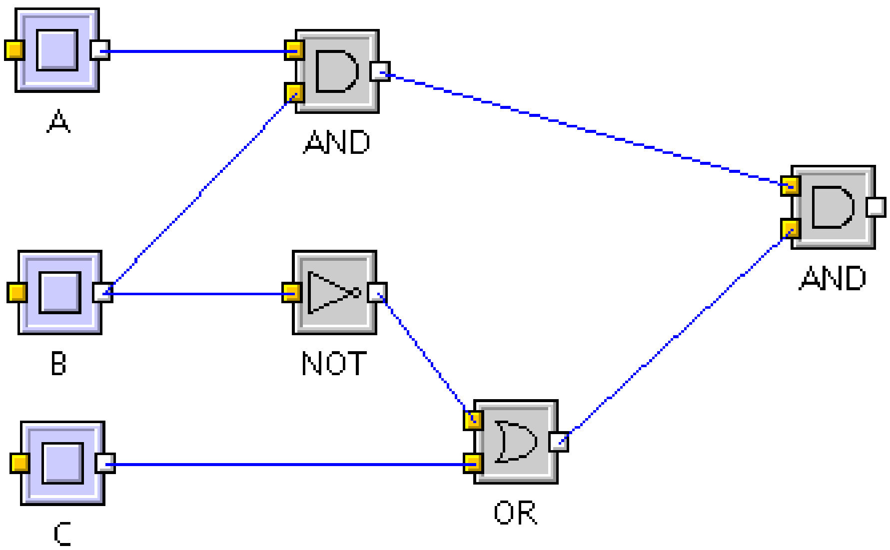
| Location | Value |
|---|---|
| 36 | 6 |
| 37 | 1 |
| 38 | 7 |
| 39 | 2 |
| 3A | 5 |

**Code:**
1 1 3 6
1 2 3 7
3 3 2 1
2 2 3 8
1 3 3 A
1 4 3 8
3 4 3 4

11. (3 points) What is a Boolean expression that is equivalent to the truth-table below?

| A | B | C | Output |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

12. (3 points) Here is a circuit.




Create a truth-table showing the value of the circuit for all possible input values of A, B, and C.

13. (3 points) Draw a circuit equivalent to the Boolean expression $(AB + C')(B' + C)$.

14. (2 points) Suppose you start with an original black and white image, and process it in the usual way and obtained image.bmp, image.jpg, and image.gif files. Order these files by size from smallest to largest. Order them in quality of image from worst to best.

15. (2 points) Name two advantages of 2's complement notation.

16. **True or False:** The ALU consists of the CPU and the control unit.

17. **True or False:** The bus is used to make sure all computers reach their final destination quickly and efficiently

18. What is a cache?

19. (2 points) What problem exactly does the Huffman approach solve? Briefly describe the method that Huffman uses.

20. (2 points) What is the difference between sequential and combinational circuits? Where in the computer are sequential circuits used?