# Final, CSCI 210, Spring 2004

**Name:** _____

**1.** [5 pts] How many bits does a kilobyte contain?

**2.** [7 pts] Approximate $2^{48}$ in the form $x \times 10^y$, with $x$ and $y$ both being base-10 numbers. (Your answer need not be normalized.)

**3.** [8 pts] In the following function, you can assume that `place` is a power of two. Complete the function so that it returns 1 if the bit of that value in `number` is set, and 0 otherwise. For example, `isBitSet(100, 4)` should return 1, since $100_{(10)} = 1100100_{(2)}$, which has a 1 in the 4's place. But `isBitSet(27, 4)` should return 0, since $27_{(10)} = 11011_{(2)}$.

```
int isBitSet(int number, int place) {




}
```

**4.** [10 pts] What does the C program at right print when run?

```
#include <stdio.h>

int main() {
    int i;   int j;
    int **p; int *q;

    i =  2;
    j =  3;
    q = &i;
    p = &q;
    *q = 5;
    q = &j;
    **p = 7;
    printf("%d %d\n", i, j);
    printf("%d %d\n", **p, *q);
    return 0;
}
```

**5.** [10 pts] Suppose we are using a HYMN computer, and the contents of registers and memory are as follows as it completes the execution of an instruction. (All numbers in the table are hexadecimal.)

PC: 03
IR: E5
AC: 09

| $a$ | M[$a$] | $a$ | M[$a$] | $a$ | M[$a$] | $a$ | M[$a$] |
|---|---|---|---|---|---|---|---|
| 00 | 86 | 08 | 00 | 10 | 00 | 18 | 00 |
| 01 | BF | 09 | 00 | 11 | 00 | 19 | 00 |
| 02 | E5 | 0A | 00 | 12 | 00 | 1A | 00 |
| 03 | 61 | 0B | 00 | 13 | 00 | 1B | 00 |
| 04 | 00 | 0C | 00 | 14 | 00 | 1C | 00 |
| 05 | 01 | 0D | 00 | 15 | 00 | 1D | 00 |
| 06 | 0A | 0E | 00 | 16 | 00 | 1E | 00 |
| 07 | 00 | 0F | 00 | 17 | 00 | 1F | 00 |

(The memory table at right lists each memory location's memory address, followed by the data at the address. For example, the location with address $06_{(16)}$ holds $0A_{(16)}$.) Modify the diagram to reflect how the registers and memory change during the fetch process.

**6.** [10 pts] Give an example where the optimization of *common subexpression elimination* applies, and explain how it applies to your example. You can write your example in C/Java, or you can write it in x86/HYMN assembly.

**7.** [10 pts] Distinguish between the terms *static linking* (i.e., compile-time linking) and *dynamic linking* (i.e., load-time or run-time linking).

**8.** [10 pts] Suppose we have two threads using the code at right. One frequently calls `advance` to advance the computation of primes, while another frequently calls `output` to output the current information.

**a.** Describe a situation in which `output` may display erroneous information.

**b.** Edit the code at right to fix this. Your fix must allow a thread to execute `output` even when another thread is inside the `isPrime` method.

```
public class PrimeCounter {
    private int last_checked = 1;
    private int primes_found = 0;

    public void advance() {
        if(isPrime(last_checked + 1)) {
            last_checked++;
            primes_found++;
        } else {
            last_checked++;
        }
    }

    public void output() {
        System.out.println(primes_found
            + " primes <= " + last_checked);
    }

    private boolean isPrime(int n) {
        for(int i = 2; i * i <= n; i++) {
            if(n % i == 0) return false;
        }
        return true;
    }
}
```

**9.** [10 pts] Describe the inputs and outputs of a (1-way) $2 \times 4$ demultiplexer, and explain how they relate.

**10.** [10 pts] Suppose we have a system using six-bit addresses which uses a direct-mapped cache with two lines, where each line has four bytes. And suppose the following sequence of accesses of one-byte accesses: M[0], M[2], M[5], M[11], M[2], M[7], M[12] (where the addresses are in base 10).

**a.** Which of the accesses in the sequence hit the cache?

**b.** Draw a picture of the contents of the cache after completing this sequence.

| line | tag | line data |
|---|---|---|
| 0 | | |
| 1 | | |

**11.** [10 pts] Suppose we are using a FAT-16 filesystem in which each block takes two kilobytes. Recall that each directory entry in FAT-16 takes 32 bytes. How much total disk space does a directory and the 100 files in it consume, if each file contains precisely five bytes? Express your answer in kilobytes.

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