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|---------------|--------------------------|-------------|
| COS 126 | General Computer Science | Spring 2010 |
| Exam 1 | | |

This test has 8 questions worth a total of 45 points. You have 50 minutes. The exam is closed book, except that you are allowed to use a one page cheatsheet. No calculators or other electronic devices are permitted. Give your answers and show your work in the space provided. **Write out and sign the Honor Code pledge before turning in the test.**

“I pledge my honor that I have not violated the Honor Code during this examination.”

Name:

Signature

NetID:

| Problem | Score |
|---------|-------|
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| Total | |

- P01 TTh 1:30 Jen
- P01A TTh 1:30 Tim
- P01B TTh 1:30 Donna
- P01C TTh 1:30 Doug
- P01D TTh 1:30 Casey
- P02 TTh 2:30 Doug
- P03 TTh 3:30 Jen
- P04 TTh 7:30 Aleksey
- P05 WF 10 Kevin
- P06 WF 1:30 Donna
- P06A WF 1:30 Chris
- P06B WF 1:30 Kevin

TOY REFERENCE CARD

INSTRUCTION FORMATS

| | | |
|-----------|---|------------|
| | | |
| Format 1: | opcode d s t | (0-6, A-B) |
| Format 2: | opcode d addr | (7-9, C-F) |

ARITHMETIC and LOGICAL operations

| | |
|----------------|------------------------------------|
| 1: add | $R[d] \leftarrow R[s] + R[t]$ |
| 2: subtract | $R[d] \leftarrow R[s] - R[t]$ |
| 3: and | $R[d] \leftarrow R[s] \& R[t]$ |
| 4: xor | $R[d] \leftarrow R[s] \wedge R[t]$ |
| 5: shift left | $R[d] \leftarrow R[s] \ll R[t]$ |
| 6: shift right | $R[d] \leftarrow R[s] \gg R[t]$ |

TRANSFER between registers and memory

| | |
|-------------------|---|
| 7: load address | $R[d] \leftarrow \text{addr}$ |
| 8: load | $R[d] \leftarrow \text{mem}[\text{addr}]$ |
| 9: store | $\text{mem}[\text{addr}] \leftarrow R[d]$ |
| A: load indirect | $R[d] \leftarrow \text{mem}[R[t]]$ |
| B: store indirect | $\text{mem}[R[t]] \leftarrow R[d]$ |

CONTROL

| | |
|--------------------|---|
| 0: halt | halt |
| C: branch zero | if ($R[d] == 0$) $pc \leftarrow \text{addr}$ |
| D: branch positive | if ($R[d] > 0$) $pc \leftarrow \text{addr}$ |
| E: jump register | $pc \leftarrow R[d]$ |
| F: jump and link | $R[d] \leftarrow pc; pc \leftarrow \text{addr}$ |

Register 0 always reads 0.

Loads from mem[FF] come from stdin.

Stores to mem[FF] go to stdout.

16-bit registers (using two's complement arithmetic)

16-bit memory locations

8-bit program counter

2. **Scope. (6 points)** What is the output of the following program? Circle your answer.

```
public class PassByValue {  
  
    public static void f(int x, int[] y, int[] z) {  
        x = 1;  
        y[0] = 2;  
        z = new int[5];  
        z[0] = 555;  
    }  
  
    public static void main(String[] args) {  
        int x = 111;  
        int[] y = { 222, 333, 444, 555 };  
        int[] z = { 666, 777, 888, 999 };  
  
        f(x, y, z);  
  
        System.out.println(x);  
        System.out.println(y[0]);  
        System.out.println(z[0]);  
    }  
}
```

3. Number Systems. (8 points)

(a) What is the decimal representation of the *16-bit* two's complement integer $1111\ 1111\ 1010\ 1000_2$?
Circle your answer.

(b) Write the decimal integer -65 in TOY (*16-bit* two's complement integer, in hexadecimal).
Circle your answer.

(c) How many lines of output does the following Java code fragment produce?

```
for (int i = 0; i >= 0; i++) {  
    System.out.println(i);  
}
```

Circle the best answer.

0 $2^{31} - 1$ 2^{31} $2^{32} - 1$ 2^{32} infinite

(d) What is the value of `answer` when the Java loop terminates?

```
int answer = 0;  
for (int i = 0; i < 256; i++) {  
    answer = answer ^ i;  
}
```

Circle the best answer.

0 1 255 256 NaN integer overflow

4. Java Expressions. (9 points)

(a) Assume that `a`, `b`, and `c` are variables of type `boolean`. Consider the following three conditions.

- i. `(a || b) && c`
- ii. `(a && b) || c`
- iii. `!(a && b) && c`

Which of the expressions above is (are) always true if `a` and `b` have different values (e.g., one is true and one is false) and `c` is true? Circle the expressions that evaluate to true.

(b) What is the type and value of each of the following expressions?

| Expression | Type | Value |
|-------------------------------|------|-------|
| <code>11 * 0.2</code> | | |
| <code>(int) 11 * 0.2</code> | | |
| <code>11 * (int) 0.2</code> | | |
| <code>(int) (11 * 0.2)</code> | | |

(c) Assuming `i` is a 32-bit integer, consider the following three expressions.

- i. `(i >> 16) & 15`
- ii. `(i & 0x000F0000) >> 16`
- iii. `(i & 0x000FF000) >> 16`

Which of the expressions are equivalent? Circle the best answer.

- i and ii
- ii and iii
- i and iii
- i, ii, and iii
- None

5. **Arrays. (9 points)** The following program prints three lines of output. What are the three lines? Circle your answer.

```
public class Mystery {
    public static void main(String[] args) {
        // Part 1
        int[] a = {0, 1, 2, 3, 4, 5};
        for (int i = 0; i < 6; i++)
            System.out.print(a[i/2] + " ");
        System.out.println();

        // Part 2
        for (int i = 5; i >= 0; i--)
            System.out.print(5 - a[a[i]] + " ");
        System.out.println();

        // Part 3
        for (int i = 0; i < 3; i++) {
            int t = a[i];
            a[i] = a[5-i];
            a[5-i] = t;
            System.out.print(a[i] + " ");
        }
        System.out.println(a[3] + " " + a[4] + " " + a[5]);
    }
}
```

6. **Recursive Methods. (3 points)** The function below is supposed to sum all the odd, or all the even, positive integers up to n , depending on whether n is odd or even.

```
public static int f(int n) {  
    if (n==0 || n==1) return n;  
    return n + f(n-2);  
}
```

Circle any of the following that are correct:

- (a) base case written incorrectly, so function will get the wrong answer, or no answer, for some valid positive values of n
- (b) reduction step written incorrectly, so function will get the wrong answer, or no answer, for some valid positive values of n
- (c) function is tail-recursive and therefore will get the wrong answer, or no answer, for some valid positive values of n
- (d) this function looks fine to me
- (e) it doesn't have problems a, b, or c, but does have the following problem, which will cause it to get the wrong answer, or no answer, for some valid positive values of n (write the problem down)

7. **Arrays and I/O. (4 points)** Consider the following program.

```
public class Mystery {
    public static void main(String[] args) {
        int N = args.length;
        String[] a = new String[N * 2];
        for (int i = 0; i < N; i++) {
            a[i] = args[i];
            a[i + N] = args[N - i - 1];
        }
        for (int i = 0; i < a.length; i++)
            StdOut.print(a[i] + " ");
        StdOut.println();
    }
}
```

(a) What does this program print out when the following command is executed?

```
% java Mystery aaa bbb ccc
```

(b) What does this program print out when the following command is executed?

```
% java Mystery aaa bbb ccc | java Mystery xxx yyy
```