NAME: **login ID:**
precept:

COS 126 Written Exam 1, Fall 2010

This test has 8 questions, weighted as indicated. 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. *Print your name, login ID, and precept number on this page* (*now*), and write out and sign the Honor Code pledge before turning in the test. You have 50 minutes to complete the test.

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

_____

Signature

1	/8
2	/8
3	/7
4	/5
5	/6
6	/9
7	/9
8	/8
TOTAL	/60

October 21, 2010

1. **Number conversion** (8 points). Solve the following four number conversion problems:

   A. Convert 1CE from hexadecimal to decimal (base 10) _____

   B. Convert F1CE from hexadecimal to 16-bit binary _____

   C. Convert 126 from decimal to hexadecimal _____

   D. Convert `1111111110110000` from 16-bit two's complement to decimal: _____

2. **Expressions** (8 points). Give the type and value of each of the following Java expressions. For "value" you *must* use one of the following:

`0`, `1`, `0.0`, `1.0`, `NaN`, `Infinity`, `true` or `false`.

If an expression will not compile, write `Illegal` under "type" and leave "value" blank.

	type	value
A. `3 - (int) "2.0"`	_____	_____
B. `4 / 6 * 1.5`	_____	_____
C. `1/1/0`	_____	_____
D. `1./1/0`	_____	_____
E. `1/(1./0)`	_____	_____
F. `true && !(0 < -1)`	_____	_____
G. `!(!!false || !!true)`	_____	_____
H. `1 < 2 < 3`	_____	_____

3. **TOY** (7 points). Suppose that `R2` contains the value `x`, a small integer between 0 and 9. Match each instruction with the description of the value of `R2` after it is executed by writing a single letter to its left. The values may be used once, more than once, or not at all.

___	`1000`	`A. 0`
___	`4222`	`B. 2*x`
___	`1222`	`C. x*x`
___	`5222`	`D. 2 raised to the power x`
___	`E022`	`E. x*(2 raised to the power x).`
___	`7022`	`F. x - 2`
___	`1202`	`G. x`
		`H. No match.`

The TOY reference card is on the next page.

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] <- R[s] + R[t]
2: subtract	R[d] <- R[s] - R[t]
3: and	R[d] <- R[s] & R[t]
4: xor	R[d] <- R[s] ^ R[t]
5: shift left	R[d] <- R[s] << R[t]
6: shift right	R[d] <- R[s] >> R[t]

TRANSFER between registers and memory

7: load address	R[d] <- addr
8: load	R[d] <- mem[addr]
9: store	mem[addr] <- R[d]
A: load indirect	R[d] <- mem[R[t]]
B: store indirect	mem[R[t]] <- R[d]

CONTROL

0: halt	halt
C: branch zero	if (R[d] == 0) pc <- addr
D: branch positive	if (R[d] > 0) pc <- addr
E: jump register	pc <- R[d]
F: jump and link	R[d] <- pc; pc <- addr

Register 0 always reads 0.
Loads from mem[FF] come from stdin.
Stores to mem[FF] go to stdout.

4. **Arrays and loops** (5 points). Consider the following Java program.

```
public class Test
{
   public static void main(String[] args)
   {
      int[] x = {1, 2, 3, 4};
      char[] y = {'a', 'b', 'c', 'd'};
      for (int i = 0; i < x.length; i += 2)
         for (int j = y.length-1; j > 0; j--)
            if (((i+j) % 2) == 0)
               System.out.print(x[i]);
            else
               System.out.print(y[j]);
   }
}
```

Which of the following does this program print? Circle your answer.
Note: The value of `k % 2` is `0` only when `k` is even.

A. `d1bd3b`

B. `d1b1d3b3`

C. `d12cd34c`

D. `2c24c4`

E. `d1b2c2d3b4c4`

5. **Methods** (6 points). Consider the following method signatures, then answer the following three questions by listing the letter(s) of the appropriate answers. A question may have zero answers, not every letter may be used, and some letters may be used more than once.

```
a. public static double min(double a, double b, int c)
b. public static double min(double a, double b, double c)
c. public static int min(int a, int b, int c)
d. public static int min(double a, int b, int c)
e. public static void min(int a, int b, int c)
f. public static double min(double a, int b, int c)
```

A. Which of these would be an effective design for providing clients with the ability to find the minimum of three `int` values, without using any explicit casts?

_____

B. Which of these would be an effective design for providing clients with the ability to find the minimum of three `double` values, without using any explicit casts?

_____

C. Which of these would be an effective design for providing clients with the ability to find the minimum of one `double` and two `int` values, without using any explicit casts?

_____

6. **Recursive method** (9 points). A palindrome is a word that reads the same forward and backward. The following program prints a special kind of palindrome.

```
public class Palindrome
{
  public static void main(String[] args)
  {
    int N = Integer.parseInt(args[0]);
    System.out.println(palindrome(N));
  }

  public static String palindrome(int i)
  {
    if (i == 0) return "S";
    if (i == 1) return "T";
    return palindrome(i-2)
                + palindrome(i-1)
                    + palindrome(i-2);
  }
}
```

A. Give the string printed when this program is run with

```
% java Palindrome 3
```

_____

B. Give the string printed when this program is run with

```
% java Palindrome 4
```

_____

C. Give the *length* of the string printed for

```
% java Palindrome 7
```

_____

7. **Debugging** (9 points). Consider the following program, which is supposed to print out the powers of `3` from `3^0` up to and including `3^N`, where `N` is a non-negative integer that is read from the command line.

```
 1 public class PowersOfThreeBuggy
 2 {
 3    public static void main(String[] args)
 4    {
 5       int N = args[0];
 6       long result = 0;
 7       int i = 0;
 8       while (i < N)
 9       {
10          System.out.println("3^" + i + " = " + result);
11          result *= 3;
12          i++;
13       }
14    }
15 }
```

This program has three bugs.

A. Which bug prevents the program from *compiling* successfully? Identify the line number where the bug appears and give a correct version of this line of code.

Line number _____

Correct version:

B. Identify the line numbers where the two *runtime* bugs appear and give a correct version of each line of code.

Line number _____

Correct version:

Line number _____

Correct version:

8. **Performance** (8 points). A MATLAB programmer experiences the following approximate running times for a program with N inputs, for various values of N.

N	*time*
1,000	1 minute
2,000	2.8 minutes
4,000	8 minutes
8,000	22.6 minutes

Which of the following best describes the likely running time of this program for $N = 128{,}000$? Circle your answer.

A. An hour

B. Two hours

C. A day

D. Two weeks

E. A year

Which of the following best describes the order of growth of the running time of this program? Circle your answer.

A. Logarithmic

B. Linear

C. Linearithmic

D. Quadratic

E. Cubic

F. None of the above