Name:

Instructions:

1. Write your name at the top of *this* page.
2. This is a closed-book exam. No form of communication is permitted (eg, talking, texting, etc.), except with the course staff.
3. No electronic devices are permitted.
4. There are 30 multiple-choice/short-answer questions in this exam, each worth 3 points. You have 75 minutes to answer the questions.
5. Each question must be answered *with a pencil* as shown below. It will be marked as incorrect otherwise.

   Multiple-choice question: (A) (B) (C) (D) (E)

   Short answer question: 42
6. You may use the blank spaces for any scratch work.
7. Discussing the exam contents with anyone who has not taken the exam is a violation of the academic honesty code.

Problem 1. Consider running a program `Mystery.java` as follows:

```
1 $ java Mystery Fred Carol Bob Alice Dan Eve
```

a. How many command-line arguments does the program receive?

b. What is the index of the fifth command-line argument?

c. What is the fifth command-line argument?

(A) `"Eve"`
(B) `"Bob"`
(C) `"Carol"`
(D) `"Dan"`
(E) `"Alice"`

Problem 2. Consider the following program `Mystery.java`:

```
import stdlib.StdOut;
```

```
public class Mystery {
    public static void main(String[] args) {
        int x = Integer.parseInt(args[0]);
        int y = Integer.parseInt(args[1]);
        int z = x * x + 2 * x * y + y * y;
        StdOut.println(z);
    }
}
```

a. What does the program write when run with inputs 9 and 4?

b. What does the program write in general?

(A) $y^2 - x^2$

(B) $(x - y)^2$

(C) $(x + y)^2$

(D) $x^2 + y^2$

(E) $x^2 - y^2$

Problem 3. Consider the following program `Mystery.java`:

```
import stdlib.StdOut;

public class Mystery {
    public static void main(String[] args) {
        int n = Integer.parseInt(args[0]);
        int x = 0;
        int i = 1;
        while (i <= n) {
            if (i % 2 != 0) {
                x += i * i;
            }
            i++;
        }
        StdOut.println(x);
    }
}
```

a. What does the program write when run with input 10?

b. What does the program write in general?

(A) Sum of the squares of even integers less than or equal to n

(B) Sum of the squares of odd integers less than or equal to n

(C) Sum of the squares of integers less than or equal to n

(D) The value n^2

(E) Sum of the integers less than or equal to n

Problem 4. Consider the following program `Mystery.java`:

```
public class Mystery {
    public static void main(String[] args) {
        int[] a = {1, 2, 3};
        int[] b = {4, 5, 6};
        int x = 0;
        for (int i = 0; i < a.length; i++) {
            x += a[i] * b[i];
        }
    }
}
```

a. What is the value of `x` after the first iteration of the for loop?

b. What is the value of `x` after the last iteration of the for loop?

Problem 5. Consider the following program `Mystery.java`:

```
public class Mystery {
    public static void main(String[] args) {
        int[][] a = {{1}, {2, 3}, {4, 5, 6}, {7, 8, 9, 10}};
        int x = 0;
        for (int i = 0; i < a.length; i++) {
            for (int j = 0; j < a[i].length; j++) {
                x += a[i][j];
            }
        }
    }
}
```

a. What is the value of `x` after the first iteration of the outer for loop?

b. What is the value of `x` after the last iteration of the outer for loop?

Problem 6. Consider the following program `Mystery.java`:

```
import stdlib.StdIn;
import stdlib.StdOut;

public class Mystery {
    public static void main(String[] args) {
        String x = StdIn.readString();
        String y = StdIn.readString();
```

```
        StdOut.print(x + "L" + y);
        StdOut.print(" ");
        StdOut.print(y + "R" + x);
        StdOut.println();
    }
}
```

Next, suppose that the file `input.txt` contains the two strings `F` and `F` separated by a space.

a. What does the command `java Mystery < input.txt` write?

(A) `FLFLFRFLFRFRFLFLFRFRFLFRFLFLFRF FRFRFLFRFLFLFRFRFLFLFRFLFRFRFLF`

(B) `FLF FRF`

(C) `F F`

(D) `FLFLFRF FRFRFLF`

(E) `FLFLFRFLFRFRFLF FRFRFLFRFLFLFRF`

b. What does the command `java Mystery < input.txt | java Mystery` write?

(A) `FLFLFRFLFRFRFLFLFRFRFLFRFLFLFRF FRFRFLFRFLFLFRFRFLFLFRFLFRFRFLF`

(B) `FLF FRF`

(C) `F F`

(D) `FLFLFRF FRFRFLF`

(E) `FLFLFRFLFRFRFLF FRFRFLFRFLFLFRF`

Problem 7. Consider the following functions:

```
private static int f(int x, int k) {
    return k * x + 1;
}

private static int g(int x, int k) {
    return x % k;
}
```

a. What does `f(6, 5)` return?

b. What does `g(19, 7)` return?

c. What does `g(f(6, 3), 5)` return?

d. What does `f(g(19, 7), 3)` return?

Problem 8. Consider the following recursive function:

```
public static int mystery(int a, int b) {
    return (b == 0) ? 1 : a * mystery(a, b - 1);
}
```

a. What does `mystery(3, 0)` return?

b. What does `mystery(3, 1)` return?

c. What does `mystery(3, 4)` return?

d. What does `mystery(a, b)` return in general about a and b?

(A) a^b
(B) ab
(C) $a + b$
(D) $a \bmod b$
(E) $|a - b|$

Problem 9. Consider the following functions:

```
private static int f(String s, char c) {
    int x = 0;
    for (int i = 0; i < s.length(); i++) {
        x += (s.charAt(i) == c) ? 1 : 0;
    }
    return x;
}

private static int g(String s) {
    char[] x = {'a', 'e', 'i', 'o', 'u'};
    int y = 0;
    for (char c : x) {
        y += f(s, c);
    }
    return y;
}
```

a. What does `f("abracadabra", 'b')` return?

b. What does `g("abracadabra")` return?

c. What does `f("alacazam", 'z')` return?

d. What does `g("alacazam")` return?

Problem 10. Consider the following data type called `Mystery`:

```
public class Mystery implements Comparable<Mystery> {
    private int x;

    public Mystery(int x) {
        this.x = x;
    }

    public int f() {
        this.x *= 2;
        return this.x;
    }

    public int g() {
        this.x++;
        return this.x;
    }

    public int compareTo(Mystery other) {
        return this.x - other.x;
    }
}
```

Next, consider the following code:

```
Mystery m1 = new Mystery(3);
Mystery m2 = new Mystery(7);

int a = m1.f(), b = m2.f();
int c = m1.g(), d = m2.g();
int e = m2.compareTo(m1);
```

a. What is the value of `a`?

b. What is the value of `b`?

c. What is the value of `c`?

d. What is the value of `d`?

e. What is the value of `e`?

Solution 1.

a. `6`

b. `4`

c. `D`

Solution 2.

a. `169`

b. `C`

Solution 3.

a. `165`

b. `B`

Solution 4.

a. `4`

b. `32`

Solution 5.

a. `1`

b. `55`

Solution 6.

a. `B`

b. `D`

Solution 7.

a. `31`

b. `5`

c. `4`

d. `16`

Solution 8.

a. `1`

b. `3`

c. `81`

d. `A`

Solution 9.

a. `2`

b. `5`

c. `1`

d. `4`

Solution 10.

a. `6`

b. `14`

c. `7`

d. `15`

e. `8`