**44-542 Object Oriented Programming**

**Recursion**

**Objective** This worksheet will give you practice in working with recursive methods.

1. The greatest common divisor of two integers a and b, where a > 0 and b >= 0, is the largest integer that is a divisor of both a and b. For example, the greatest common divisor of 18 and 12 is 6 and the greatest common divisor of 9 and 8 is 1. Euclid discovered an algorithm for computing greatest common divisor about 2300 years ago. It may be stated using recursion:

**gcd(a, b) = gcd(b, a modulo b) if b > 0;**

**gcd(a, 0) = a.**

Using this definition, we see that

**gcd(18, 12) = gcd(12, 6) = gcd(6, 0) = 6, and**

**gcd(9, 8) = gcd(8, 1) = gcd(1, 0) = 1**

Find each of the following, showing each step as in the examples above.

* 1. **gcd(48, 39)**
  2. **gcd(12, 15)**
  3. **gcd(1234, 456)**

1. Consider a method f defined as follows:

if n == 0, then f returns 0;

otherwise, f returns n \* n + f(n – 1);

For example,

**f(2) = 2 \* 2 + f(1) = 4 + f(1) = 4 + (1 \* 1 + f(0))**

**= 4 + (1 + f(0)) = 4 + (1 + 0) = 4 + 1 = 5**

Find the value returned by each of the following. Show each step, as in the example above.

* 1. **f(3)**
  2. **f(5)**
  3. **f(10)**
  4. What does method f do in general?

1. Recall that the factorial fact(n) of a positive integer n is the product of the integers 1 through n. Thus fact(3) has the value 6 = 1 \* 2 \* 3. Also, fact(0) is defined to be 1. Factorial may be defined recursively:

**fact(n) = n \* fact(n - 1) if n > 0;**

**fact(0) = 1**

For example,

**fact(2) = 2 \* fact(1) = 2 \* (1 \* fact(0)) = 2 \* (1 \* 1) =**

**2 \* 1 = 2**

Find the value returned by each of the following. Show each step, as in the example above.

* 1. **fact(3)**
  2. **fact(5)**
  3. **fact(7)**

1. Consider the method mystery:

**public static void mystery (long n)**

**{**

**System.out.print(n % 10);**

**if ((n / 10) != 0)**

**{**

**mystery(n / 10);**

**}**

**}**

Find the output produced by each of the following calls to the method **mystery**:

* 1. **mystery(29)**
  2. **mystery(12345)**
  3. What does the method **mystery** do in general?