NAME:_________________________________________

CU ID:________________________________________

Recitation instructor____________________________

Did you take CS 100M or 100J? If so, when?____________________________

You have one and a half hours to do this exam.

All programs in this exam must be written in Java.

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1. (30 points) The great basketball player Kareem Abdul-Java has written the following Java program which may have some errors in it.

(a) (6 points) Explain the terms *shadowing of variables* and *method overriding* in the context of object-oriented languages. Use 5 or fewer sentences for each term.

(b) (24 points) What will each of the 12 print statements in the program shown overleaf print? Write “error” for any print statement that is incorrect. Enter your answers in the space shown next to each print statement.
interface I1{
    int m1();
}
interface I2 extends I1{
    int m2();
}
class B implements I1 {
    int i = 7;
    public int m1() {
        return i;
    }
}
class C extends B implements I2{
    int i = -7;
    public int m2() {
        return i;
    }
    public int m1() {
        return i;
    }
}
class Class1 {
    public static void main(String[] a) {
        B bee = new C();
        System.out.println(bee.i);  //will print 
        System.out.println(bee.m1());  //will print 
        System.out.println(bee.m2());  //will print 

        I1 eye = (I1) bee;
        System.out.println(eye.i);  //will print 
        System.out.println(eye.m1());  //will print 
        System.out.println(eye.m2());  //will print 

        C cee = (C) bee;
        System.out.println(cee.i);  //will print 
        System.out.println(cee.m1());  //will print 
        System.out.println(cee.m2());  //will print 

        I2 me2 = (I2) bee;
        System.out.println(me2.i);  //will print 
        System.out.println(me2.m1());  //will print 
        System.out.println(me2.m2());  //will print 
    }
}
2. (25 points) Use induction to prove the following fact. State carefully what the base and inductive cases are.

(a) (10 points) (easy)
\[
\frac{1}{1 \cdot 2} + \frac{1}{2 \cdot 3} + \frac{1}{3 \cdot 4} + \ldots + \frac{1}{(n-1)n} = \frac{(n-1)}{n}
\]

(b) (15 points) (tricky)
\[
\frac{1 \cdot 3 \cdot 5 \ldots (2n-1)}{2 \cdot 4 \cdot 6 \ldots 2n} \leq \frac{1}{\sqrt{(2n+1)}}
\]
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3. (25 points)

The following grammar describes arithmetic expressions that are similar to the ones discussed in lectures, except that function calls can appear as part of an expression. For simplicity, we will assume that a function can take only one parameter.

$$E \rightarrow integer$$
$$E \rightarrow variable$$
$$E \rightarrow variable(E)$$
$$E \rightarrow (E + E)$$

Here are some expressions that are legal in this language.

$$(4 + (x + f(7)))$$
$$f((4 + y))$$

Write a recursive program that takes a file as input, and returns true if the file contains a single expression that is legal according to this grammar, and false otherwise. You must use the CS211In class for reading from the file.

Here is the interface to the CS211In class.

```java
interface CS211InInterface {
    int
        INTEGER = -1,
        WORD = -2,
        OPERATOR = -3,
        EOF = -4;
    int peekAtKind();  //returns one of the integers above
    int getInt();      //read an integer from the file
    String getWord();
    char getOp();
    boolean check(char c); //is the next token in the file operator c?
    boolean check(String s); //is the next token in the file word s?
    void pushBack();  //back up the file-pointer by one token in the file
    void close();    //...
}
```
Here is a shell of the program to get you started.

```java
static boolean parse(CS211In f) {
    boolean gotIt = getExp(f);
    if (f.peekAtKind() == f.EOF)
        return gotIt;
    else return false;
}

static boolean getExp(CS211In f) {
    switch(f.peekAtKind()) {
```
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4. (20 points)

- (14 points) Write a public static Java method to convert a string containing only the characters 0 through 9 into its integer value. For example, given the string ”0076”, the method should return the integer 76. You will graded for efficiency, so make your code as efficient as possible. You may find the following instance methods of the String class useful:
  - int length(): returns the number of characters in the string
  - char charAt(int n): returns the character at position n of the string

- (6 points) Suppose s1 and s2 are two variables of type String. What do each of these constructs do?
  - s1 = s2;
  - (s1 == s2)
  - (s1.equals(s2))
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