CSC 1051 Algorithms and Data Structures I

Midterm Examination
October 7, 2013

Name:__________________________________________

<table>
<thead>
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Please answer questions in the spaces provided. If you make a mistake or for some other reason need more space, please use the back of pages or the extra blank page at the end and clearly indicate where the answer can be found. Good luck!

   a) If a language uses 30 unique letters and symbols, how many bits would be needed to store each character of a document? Explain.

   b) Give examples of two types of Java comments and explain the differences between them.

   c) Java is case sensitive. What does that mean?

   d) What is a variable declaration? Give two examples.

   e) Why are widening conversions safer than narrowing conversions?
2. [ /10] List the following items with respect to the code below:

a) a boolean expression

b) all variable identifiers for integers

c) all variables identifiers for floating point numbers

d) all constant identifiers (any type of value)

e) a comment

f) an input statement

g) an output statement

h) a statement that is executed conditionally

// Wages.java calculates wages with overtime.
//********************************************************************
import java.text.NumberFormat;
import java.util.Scanner;
public class Wages {
    public static void main (String[] args) {
        final double RATE = 8.25; // regular pay rate
        final int STANDARD = 40; // standard hours in a work week
        Scanner scan = new Scanner (System.in);
        double pay = 0.0;
        System.out.print ("Enter the number of hours worked: ");
        int hours = scan.nextInt();
        System.out.println();
        // Pay overtime at "time and a half"
        if (hours > STANDARD)
            pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
        else
            pay = hours * RATE;
        NumberFormat fmt = NumberFormat.getCurrencyInstance();
        System.out.println ("Gross earnings: " + fmt.format(pay));
    }
}
3. [10] **Short answer questions.**

a) [7 points] Suppose you want to draw a yellow circle inside a green square, positioned at the top left corner of your applet. The square should have sides of length 80 pixels and the circle should have a smaller diameter, 40 pixels. As usual, the paint method is passed a Graphics object called page. Here is a start – finish writing the Java code:

```java
page.setColor(Color.green); // finish writing this code
page.fillRect(
```

b) [3 points]

```java
if (a>0)
    if (b<0)
        x = x + 5;
    else
        if (a>5)
            x = x + 4;
        else
            x = x + 3;
else
    x = x + 2;
```

If x is currently 0, a = 5 and b = 5, what will x become after the above statement is executed?
4. [10] What gets printed by the following program?

```java
public class Mystery {
    public static void main(String args[]) {
        String str = "midterm";
        int left = 0;
        int right = str.length() - 1;

        while (str.charAt(left) == str.charAt(right) && left < right) {
            System.out.println("Yes!");
            System.out.println("left = " + left);
            System.out.println("right = " + right);
            System.out.println("The characters are " +
                              str.charAt(left) +
                              str.charAt(right));

            left ++;
            right --;
        }

        System.out.println("Out of the loop now");
        System.out.println("left = " + left);
        System.out.println("right = " + right);
        System.out.println("The characters are " +
                          str.charAt(left) +
                          str.charAt(right));
    }
}
```

Output
5. [ /10] Recall that the Random class is part of the java.util package.

a) Write an import declaration for the Random class

b) Write some code to declare and instantiate an object of the Random class (call the object reference \texttt{rand}).

c) Write some code that uses the object \texttt{rand}, above, to generate pseudorandom numbers in the following specified ranges (including the endpoints):

0 to 9

1 to 100

0 to .4999999 (i.e., as close to 0.5 as it gets, but not including 0.5)

For each of the following expressions, indicate the order in which the operations are performed by writing a number beneath each operator.

\[ a / b - d * e + f \]

\[ a / (b + c) / e - f \]

For each of the following Java code fragments, mark the error and show how to correct it. What do you need to do to fix it so that it works as appears to be intended?

a)

```java
if (value = 0)
    System.out.print ("Right!");
```

b)

```java
if (value > 0);
    System.out.print ("Right!");
```

c)

```java
if (value > 0)
    System.out.print ("Right!");
    System.out.println(" value is positive");
```
7. [ /10] Given the following declarations:

```c
int iResult, num1= 5, num2 = 2;
double fResult, val1 = 8.0;
```

Show the results if the following assignment statements are executed (or write “ERROR” if the statement causes an error).

- The resulting value of the expression that will be stored in the variable and its type
- The kind of data conversion, i.e., one of the following:
  - none (no data conversion of any kind)
  - automatic (through assignment or mixed type expression)
  - cast (specify whether widening or narrowing)
- Note that there may be none or more than one conversion – be sure to list all, if any

**FOR EACH ANSWER WRITE AN EXPLANATION**

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<td></td>
<td></td>
<td></td>
</tr>
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<td>iResult = (int) val1 / num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = (double) num1 / num2;</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
8. [  / 10] What gets printed?
Please show output as it will appear, or indicate “NO OUTPUT”, or show some of the output followed by “INFINITE LOOP.”

```java
int a = 0;
while (a<6) {
    System.out.println(a);
    a++;
}
```

Output:
```
0
1
2
3
4
5
```

```java
int a = 0;
while (a<6) {
    System.out.println(a);
    a++;
}
// (same as previous one, only no braces)
```

Output:
```
0
1
2
3
4
5
```

```java
int a = 5;
while (a > 5) {
    System.out.println(a);
    a = a - 2;
}
```

Output:
```
5
3
1
```

```java
int a = 1;
while (a >= 1) {
    System.out.println(2*a);
    a++;
}
```

Output:
9. (_____/ 10)

Construct an algorithm that inputs several positive integers in the range 1...100 from the user, terminated with a -1 (sentinel value). The algorithm should print the numbers entered and determine and print the minimum value. After the minimum is printed, print a goodbye message. You can assume that the numbers entered will be between 1 and 100 (except for the terminating -1), so you do not need to check for mistakes in the input.

Note: Be careful not to process the terminating -1, i.e., make sure your algorithm does not produce -1 as the minimum.

Example: If the numbers 25 86 13 54 -1 are entered as input, the algorithm should print:

```
25
86
13
54
Min = 13
Goodbye
```

[Note that the terminating -1 should NOT be printed.]

Directions:
Write your algorithm by rearranging and structuring elements chosen from the list below, using indentation to show structure. Do not use anything else and note that not all of these are needed, but you may use one of them more than once, if necessary.

```
input num
input min
num = 0
min = 0
min = 100
num = num + 1
min = num
num = min
if (num < min)
if (num > min)
if (num != -1)
if (num != min)
else
while (num < min)
while (num > min)
while (num != -1)
print "Min = ", min
print "Min = ", num
print num
print "Goodbye"
```
10. (_____/ 10) Write a **complete Java program** that asks the user to input his/her age and then calculates and prints the user’s age in days (ignore leap years – assume all years have 365 days).

Be sure to write a **complete Java program**, including class definition, variable and constant declarations, as appropriate, comments, and proper indentation, to make it readable.
Drawing a Line

```
page.drawLine (10, 20, 150, 45);
```

Drawing a Rectangle

```
paint (Graphics page)
    page.drawRect (50, 20, 100, 40);
```

Drawing an Oval

```
paint (Graphics page)
    page.drawOval (175, 20, 50, 80);
```

Drawing an Arc

```
page.drawArc (x1, y1, x2, y2, startAngle, arcAngle);
```

Filled vs unfilled shapes

- Instead of using drawRect(), drawOval() etc, we can use fillRect(), fillOval() etc
- We can set the color using setColor()
- See Snowman.java
- See also Snowman applet on a webpage
### Some methods of the String class

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td>boolean isEmpty()</td>
<td>Returns true if, and only if, <code>length()</code> is 0.</td>
</tr>
<tr>
<td>char charAt(int index)</td>
<td>Returns the char value at the specified index.</td>
</tr>
<tr>
<td>int length()</td>
<td>Returns the length of this string.</td>
</tr>
<tr>
<td>String toUpperCase()</td>
<td>Converts all of the characters in this String to lower case using the rules of the default locale.</td>
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### Some methods of the Random class

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<td>double nextDouble()</td>
<td>Returns the next pseudorandom, uniformly distributed double value between 0.0 and 1.0</td>
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<td>int nextInt()</td>
<td>Returns the next pseudorandom, uniformly distributed int value from this random number generator's sequence.</td>
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<td>int nextInt(int n)</td>
<td>Returns a pseudorandom, uniformly distributed int value between 0 (inclusive) and the specified value (exclusive), drawn from this random number generator's sequence.</td>
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### Some methods of the Math class

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<td>Returns the absolute value of a double value.</td>
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<td>static double cos(double a)</td>
<td>Returns the trigonometric cosine of an angle.</td>
</tr>
<tr>
<td>static double pow(double a, double b)</td>
<td>Returns the value of the first argument raised to the power of the second argument.</td>
</tr>
<tr>
<td>static double random()</td>
<td>Returns a double value greater than or equal to 0.0 and less than 1.0.</td>
</tr>
<tr>
<td>static long round(double a)</td>
<td>Returns the closest long to the argument.</td>
</tr>
<tr>
<td>static double sin(double a)</td>
<td>Returns the trigonometric sine of an angle.</td>
</tr>
<tr>
<td>static double sqrt(double a)</td>
<td>Returns the correctly rounded positive square root of a double value.</td>
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### Some Java Escape Sequences and their meaning:

- `\t` tab
- `\n` newline
- `"` double quote
- `\'` single quote
- `\\` backslash
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TOTAL 100

Please answer questions in the spaces provided. If you make a mistake or for some other reason need more space, please use the back of pages or the extra blank page at the end and clearly indicate where the answer can be found. Good luck!

f) If a language uses 50 unique letters and symbols, how many bits would be needed to store each character of a document? Explain.

g) Give examples of two types of Java comments and explain the differences between them.

h) Java is case sensitive. What does that mean?

i) What is a variable declaration? Give two examples.

j) Why are widening conversions safer than narrowing conversions?
2. [10] List the following items with respect to the code below:

a) a boolean expression

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d) all constant identifiers (any type of value)

e) a comment

f) an output statement

g) an input statement

h) a statement that is executed conditionally

// Wages.java calculates wages with overtime.
//********************************************************************
import java.text.NumberFormat;
import java.util.Scanner;
public class Wages
{
    public static void main (String[] args)
    {
        final double RATE = 8.25; // regular pay rate
        final int STANDARD = 40; // standard hours in a work week
        Scanner scan = new Scanner (System.in);
        double pay = 0.0;
        System.out.print ("Enter the number of hours worked: ");
        int hours = scan.nextInt();
        System.out.println ("");
        // Pay overtime at "time and a half"
        if (hours > STANDARD)
            pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
        else
            pay = hours * RATE;
        NumberFormat fmt = NumberFormat.getCurrencyInstance();
        System.out.println ("Gross earnings: " + fmt.format(pay));
    }
}

a) [7 points] Suppose you want to draw a red circle inside a green square, positioned at the top left corner of your applet. The square should have sides of length 100 pixels and the circle should have a smaller diameter, 80 pixels. As usual, the paint method is passed a Graphics object called page. Here is a start – finish writing the Java code:

```java
page.setColor(Color.green);   // finish writing this code
page.fillRect(
```

b) [3 points]

```java
if (a>0)
    if (b<0)
        x = x + 5;
    else
        if (a>5)
            x = x + 4;
        else
            x = x + 3;
    else
        x = x + 2;
```

If x is currently 0, a = 1 and b = -1, what will x become after the above statement is executed?
4. [ /10] What gets printed by the following program?

```java
public class Mystery {
    public static void main(String args[]) {
        String str = "elle";
        int left = 0;
        int right = str.length() - 1;

        while (str.charAt(left) == str.charAt(right) && left < right) {
            System.out.println("Yes!");
            System.out.println("left = " + left);
            System.out.println("right = " + right);
            System.out.println("The characters are " +
                                 str.charAt(left) +
                                 str.charAt(right));

            left ++;
            right --;
        }

        System.out.println("Out of the loop now");
        System.out.println("left = " + left);
        System.out.println("right = " + right);
        System.out.println("The characters are " +
                             str.charAt(left) +
                             str.charAt(right));
    }
}
```

*Output*
5. [ /10] Recall that the Random class is part of the java.util package.

a) Write an import declaration for the Random class

b) Write some code to declare and instantiate an object of the Random class (call the object reference rand).

c) Write some code that uses the object rand, above, to generate pseudorandom numbers in the following specified ranges (including the endpoints):

0 to 100

1 to 10

0 to .9999999 (i.e., as close to 10 as it gets, but not including 10)
6. [ /10] Short answer questions.

For each of the following expressions, indicate the order in which the operations are performed by writing a number beneath each operator.

\[ a - b + \frac{d}{e} / f \]

\[ b + e + a + f + c \]

For each of the following Java code fragments, mark the error and show how to correct it. What do you need to do to fix it so that it works as appears to be intended?

a) 
```java
if (value = 0)
    System.out.print ("Right!");
```

b) 
```java
if (value > 0);
    System.out.print ("Right!");
```

c) 
```java
if (value > 0)
    System.out.print ("Right!");
    System.out.println(" value is positive");
```
7. \([/10]\) Given the following declarations:

```
int iResult, num1 = 5, num2 = 2;
double fResult, val1 = 8.0;

int iResult, num1 = 5, num2 = 3;
double fResult, val1 = 6.0;
```

Show the results if the following assignment statements are executed (or write “ERROR” if the statement causes an error).

- The resulting value of the expression that will be stored in the variable and its type
- The kind of data conversion, i.e., one of the following:
  - none (no data conversion of any kind)
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8. [ 10] What gets printed?
Please show output as it will appear, or indicate “NO OUTPUT”, or show some of the output followed by “INFINITE LOOP.”

```java
int a = 0;
while (a<5)
{
    System.out.println(a);
    a++;
}
```

Output:

```
0
1
2
3
4
```

```
int a = 0;
while (a<5)
    System.out.println(a);
    a++;
// (same as previous one, only no braces)
```

Output:

```
0
1
2
3
4
```

```
int a = 6;
while (a>0)
{
    System.out.println(a);
    a = a - 2;
}
```

Output:

```
6
4
2
```

```
int a = 1;
while (a <= 6)
{
    System.out.println(2*a);
    a++;
}
```

Output:
9. (10)
Construct an algorithm that inputs 10 positive integers from the user and determines how many of the numbers entered are even (i.e., divisible by 2). The algorithm should print the numbers as they are entered, and meanwhile keep track of how many have been even (hint: use the variable evenCount). After all the numbers have been entered, print the result (how many were even) and a goodbye message.

Example: If the numbers 25 86 13 54 1 52 4 88 9 41 are entered as input, the algorithm should print:

25
86
13
55
1
52
9
88
9
41
3 of these numbers are even
Goodbye

Directions:
Write your algorithm by rearranging and structuring elements chosen from the list below, using indentation to show structure. Do not use anything else and note that not all of these are needed, but you may use one of them more than once, if necessary.

```plaintext
num = 0
count = 0
count = 1
evenCount = 0
count = count + 1
evenCount = evenCount + 1
num = num + 1
print evenCount
print "of these numbers are even"
print "Goodbye"
input num
input evenCount
```
10. (_____/ 10) Write a complete Java program that asks the user to input an integer representing a number of days and then calculates and prints the equivalent as a number of weeks and days. For example, if the user inputs 18 for the number of days, the output should state that it is equivalent to 2 weeks and 4 days.

Be sure to write a complete Java program, including class definition, variable and constant declarations, as appropriate, comments, and proper indentation, to make it readable.
Drawing a Line

```
page.drawLine (10, 20, 150, 45);
```

or

```
page.drawLine (150, 45, 10, 20);
```

Drawing a Rectangle

```
page.drawRect (50, 20, 100, 40);
```

Drawing an Oval

```
page.drawOval (175, 20, 50, 80);
```

Filled vs unfilled shapes

- Instead of using drawRect(), drawOval() etc, we can use fillRect(), fillOval() etc
- We can set the color using setColor()
- See Snowman.java
- See also Snowman applet on a webpage
## Some methods of the String class

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<td>char</td>
<td><code>charAt(int index)</code></td>
<td>Returns the char value at the specified index.</td>
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<td><code>length()</code></td>
<td>Returns the length of this string.</td>
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## Some methods of the Math class

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<td><code>cos(double a)</code></td>
<td>Returns the trigonometric cosine of an angle.</td>
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<td>static double</td>
<td><code>pow(double a, double b)</code></td>
<td>Returns the value of the first argument raised to the power of the second argument.</td>
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<td>static double</td>
<td><code>random()</code></td>
<td>Returns a double value greater than or equal to 0.0 and less than 1.0.</td>
</tr>
<tr>
<td>static long</td>
<td><code>round(double a)</code></td>
<td>Returns the closest long to the argument.</td>
</tr>
<tr>
<td>static double</td>
<td><code>sin(double a)</code></td>
<td>Returns the trigonometric sine of an angle.</td>
</tr>
<tr>
<td>static double</td>
<td><code>sqrt(double a)</code></td>
<td>Returns the correctly rounded positive square root of a double value.</td>
</tr>
</tbody>
</table>

### Some Java Escape Sequences and their meaning:

- `	` tab
- `
` newline
- `"` double quote
- `'` single quote
- `\` backslash