CSC 1051 Algorithms and Data Structures I

Midterm Examination
February 27, 2013

Name:______________________________

<table>
<thead>
<tr>
<th>Question</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

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!
1. **(10/ 10) Multiple choice questions**

- A Java program is best classified as
  A) hardware
  B) software
  C) storage
  D) processor
  E) input

- With 5 bits we can represent ________ distinct items or values
  A) 2
  B) 10
  C) 25
  D) 32
  E) 50

- Which of the following is a legal Java identifier? (check all that apply):
  A) x
  B) class2
  C) Result#1
  D) else
  E) 2bORnot2B

- An error in a program that results in the program not compiling is referred to as:
  A) a programmer error
  B) a logical error
  C) a run-time error
  D) a syntax error
  E) a snafu

- If an image is represented using grayscale color (1 byte/pixel) and we convert it to a bitmap (1 bit/pixel), then its file size should decrease by a factor of:
  a) 2
  b) 3
  c) 8
  d) 256
  e) It should not decrease, it should stay the same
1. (_____/ 10) **Multiple choice questions**

- A Java program is best classified as
  A) hardware
  B) processor
  C) software
  D) storage
  E) input

- With 1 bit we can represent ________ distinct items or values
  A) 2
  B) 10
  C) 25
  D) 32
  E) 50

- Which of the following is a legal Java identifier? (check all that apply):
  A) else
  B) class2
  C) Result#1
  D) count
  E) 2bORnot2B

- An error in a program that results in the program not compiling is referred to as:
  A) a syntax error
  B) a programmer error
  C) a logical error
  D) a run-time error
  E) a snafu

- If an image is represented using RGB color (3 bytes/pixel) and we convert it to grayscale (1 byte/pixel), then its file size should decrease by a factor of:
  a) 2
  b) 3
  c) 8
  d) 256
  e) It should not decrease, it should stay the same
2. (_____/ 10)  

Multiple choice/fill in blanks:

• Of the following if statements, which one correctly executes three instructions if the condition is true?

   a) 
   
   ```c
   if (x < 0)
   a = b * 2;
   y = x;
   z = a - y;
   ```

   b) 
   
   ```c
   { 
   if (x < 0)
   a = b * 2;
   y = x;
   z = a - y;
   }
   ```

   c) 
   
   ```c
   if { (x < 0)
   a = b * 2;
   y = x;
   z = a - y ;
   }
   ```

   d) 
   
   ```c
   if (x < 0)
   {
   a = b * 2;
   y = x;
   z = a - y;
   }
   ```

• Which of the sets of statements below will add 1 to x if x is positive and subtract 1 from x if x is negative, but leave x alone if x is 0?

   a) if (x > 0)
   
   ```c
   x++;
   ```

   else 
   
   ```c
   x--;
   ```

   b) if (x > 0)
   
   ```c
   x++;
   ```

   else if (x < 0)
   
   ```c
   x--;
   ```

   c) if (x == 0)
   
   ```c
   x = 0;
   ```

   else x++;

   ```c
   x--;
   ```

   d) x++; 

   ```c
   x--;
   ```
[Question 2, continued]

- Consider the following outline of a nested if-else structure which has more if clauses than else clauses. Which of the statements below is true regarding this structure?

  ```java
  if (condition1)
      if (condition2)
          statement1;
  else statement2;
  ```

  - statement2 will only execute if condition1 is false and condition2 is false
  - statement2 will only execute if condition1 is true and condition2 is false
  - statement2 will only execute if condition1 is false, it does not matter what condition2 is
  - syntactically it is invalid to have more if clauses than else clauses
  - statement2 will never execute

Insert appropriate Java code in the space below to perform input validation (i.e., ensure that the user inputs a number greater than zero, allowing them to keep trying again if they entered a value less than zero).

```java
//********************************************************************
//  Wages.java  Author: Lewis/Loftus
//  Reads the number of hours worked and calculates wages.
//********************************************************************
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));
    }
}
2. (_____/ 10)

Multiple choice/fill in blanks:

- Of the following if statements, which one correctly executes three instructions if the condition is true?

  a) 
  ```c
  if (x < 0)
    a = b * 2;
    y = x;
    z = a - y;
  ```

  b) 
  ```c
  if (x < 0)
    { 
      a = b * 2;
      y = x;
      z = a - y;
    }
  ```

  c) 
  ```c
  { 
    if (x < 0)
      a = b * 2;
      y = x;
      z = a - y;
  }
  ```

  d) 
  ```c
  if { (x < 0)
    a = b * 2;
    y = x;
    z = a - y;
  }
  ```

- Which of the sets of statements below will add 1 to \( x \) if \( x \) is positive and subtract 1 from \( x \) if \( x \) is negative, but leave \( x \) alone if \( x \) is 0?

  a) 
  ```c
  if (x > 0)
    x++;
  else
    x--; 
  ```

  b) 
  ```c
  if (x == 0)
    x = 0;
  else x++;
  x--; 
  ```

  c) 
  ```c
  if (x > 0)
    x++;
  else if (x < 0)
    x--;
  ```

  d) 
  ```c
  x++;
  x--; 
  ```
[ Question 2, continued]
• Consider the following outline of a nested if-else structure which has more if clauses than else clauses. Which of the statements below is true regarding this structure?
  \[
  \text{if (condition1)} \\
  \quad \text{if (condition2)} \\
  \quad \text{statement1;} \\
  \text{else statement2;} \\
  \]
  o statement2 will only execute if condition1 is true and condition2 is false
  o statement2 will only execute if condition1 is false and condition2 is false
  o statement2 will only execute if condition1 is false, it does not matter what condition2 is
  o syntactically it is invalid to have more if clauses than else clauses
  o statement2 will never execute

Insert appropriate Java code in the space below to perform input validation (i.e., ensure that the user inputs a number greater than zero, allowing them to keep trying again if they entered a value less than zero).

//****************************************************************************
// Wages.java       Author: Lewis/Loftus
// Reads the number of hours worked and calculates wages.
//****************************************************************************
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) Review the program below and for each identifier listed in the table, specify what it refers to – choose one of the following:  

<table>
<thead>
<tr>
<th>Class</th>
<th>Method</th>
<th>Object</th>
<th>Package</th>
</tr>
</thead>
</table>

(Note: some of these may occur more than once)

```java
import java.awt.*;
import javax.swing.JApplet;

public class Applet1 extends JApplet
{
    public void paint( Graphics page)
    {
        Color myColor = new Color(100,100,100); // what color is this?
        page.setColor( myColor);
        page.fillRect(0,100,150,100);
        page.setColor( Color.YELLOW );
        page.drawLine(0,100,300,200);
        page.setColor( Color.GREEN);
        page.fillOval(0,0,20,20);
    }
}
```

b) What do you think the `myColor` looks like?

c) Draw a sketch of the image displayed by the applet – indicate the color of each figure or line. Be sure to label the coordinate system.
3. (_____/ 10) Review the program below and for each identifier listed in the table, specify what it refers to – choose one of the following:

Class ....... Method......... Object......... Package
(Note: some of these may occur more than once)

<table>
<thead>
<tr>
<th>java.awt</th>
<th>JApplet</th>
<th>Graphics</th>
<th>page</th>
<th>Color</th>
<th>col</th>
<th>setColor</th>
<th>drawLine</th>
</tr>
</thead>
</table>

```java
import java.awt.*;
import javax.swing.JApplet;

class Applet1 extends JApplet {
    public void paint(Graphics page) {
        Color myColor = new Color(0, 0, 100); // what color is this?
        page.setColor(myColor);
        page.fillRect(0, 50, 200, 100);

        page.setColor(Color.RED);
        page.drawLine(100, 0, 200, 300);
        page.setColor(Color.GREEN);
        page.fillOval(0, 0, 50, 50);
    }
}
```

b) What do you think the myColor looks like?

c) Draw a sketch of the image displayed by the applet – indicate the color of each figure or line. Be sure to label the coordinate system.
4. [ /10] Given the following declarations:

```java
int iResult, num1 = 7, num2 = 3;
double fResult, val1 = 8.0;
boolean status, part1 = false;
```

Show:

- What result is stored by each of the following assignment statements?
- What is the type of the result?
- The kind of data conversion, \textit{i.e.}, one of the following:
  - assignment
  - promotion
  - cast (specify whether widening or narrowing)
  - none

<table>
<thead>
<tr>
<th>Source code</th>
<th>Result stored</th>
<th>Type</th>
<th>Data Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>fResult = num1;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iResult = num1 % num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = val1 / num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = (double) num1 / num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>status = num1 == num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. [ 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:

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

Output:

```java
int a = 5;
while (a>0)
{
    System.out.println(a);
    a = a - 2;
}
```

Output:

```java
int a = 1;
while (a <= 5)
{
    System.out.println(2*a);
    a++;
}
```

Output:
4. [15] Given the following declarations:

```java
int iResult, num1 = 7, num2 = 3;
double fResult, val1 = 8.0;
boolean status, part1 = false;
```

Show:
- What result is stored by each of the following assignment statements?
- What is the type of the result?
- The kind of data conversion, *i.e.*, one of the following:
  - assignment
  - promotion
  - cast (specify whether widening or narrowing)
  - none

<table>
<thead>
<tr>
<th>Source code</th>
<th>Result stored</th>
<th>Type</th>
<th>Data Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>fResult = num1;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iResult = num1 % num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = val1 / num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = (double) num1 / num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>status = num1 == num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


5. [ / 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:

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

Output:

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

Output:

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

Output:
4. [15] Given the following declarations:

```java
int iResult, num1 = 8, num2 = 3;
double fResult, val1 = 7.0;
boolean status, part1 = false;
```

Show:
- What result is stored by each of the following assignment statements?
- What is the type of the result?
- The kind of data conversion, i.e., one of the following:
  - assignment
  - promotion
  - cast (specify whether widening or narrowing)
  - none

<table>
<thead>
<tr>
<th>Source code</th>
<th>Result stored</th>
<th>Type</th>
<th>Data Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>iResult = num1;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iResult = num1 % num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = val1 / num2;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iResult = (int) val1;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>status = !part1</td>
<td></td>
<td>false</td>
<td></td>
</tr>
</tbody>
</table>
5. [ / 12] 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 = 7;
while (a > 0)
{
    a = a - 2;
    System.out.println(a);
}
```

Output:

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

Output:

```java
int a = 11;
while ((a%5)!=0)
{
    System.out.println(a);
    a++;  
}
```

Output:

```java
int a = 7;
while (a < 7)
{
    System.out.println (a);
    a++;
}
```

Output:
4. [15] Given the following declarations:

```java
int iResult, num1 = 8, num2 = 3;
double fResult, val1 = 7.0;
boolean status, part1 = false;
```

Show:
- What result is stored by each of the following assignment statements?
- What is the type of the result?
- The kind of data conversion, i.e., one of the following:
  - assignment
  - promotion
  - cast (specify whether widening or narrowing)
  - none

<table>
<thead>
<tr>
<th>Source code</th>
<th>Result stored</th>
<th>Type</th>
<th>Data Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>iResult = num1;</td>
<td>iResult</td>
<td>int</td>
<td>assignment</td>
</tr>
<tr>
<td>iResult = num1 % num2;</td>
<td>iResult = num1 % num2;</td>
<td>int</td>
<td>promotion</td>
</tr>
<tr>
<td>fResult = val1 / num2;</td>
<td>fResult</td>
<td>double</td>
<td>cast (narrowing)</td>
</tr>
<tr>
<td>iResult = (int) val1;</td>
<td>iResult = (int) val1;</td>
<td>int</td>
<td>cast (widening)</td>
</tr>
<tr>
<td>status = !part1</td>
<td></td>
<td>false</td>
<td>status = !part1</td>
</tr>
</tbody>
</table>
5. [ / 12] 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 = 7;
while (a < 7) {
    System.out.println(a + 1);
    a++;
}
```

Output:

```
10
11
12
```

```java
int a = 1;
while (a <= 7) {
    if ((a%2)==0)
        System.out.println(a);
    a++;
}
```

Output:

```
2
4
6
```

```java
int a = 1;
while (a < 7) {
    a++;
    System.out.println (a);
}
```

Output:

```
2
3
4
5
6
7
```

```java
int a = 7;
while (a != 0) {
    a = a - 2;
    System.out.println (a);
}
```

Output:

```
5
3
1
-1
```

CSC1051 Data Structures and Algorithms I  Dr. Papalaskari  Spring 2013
6. (______/ 10) Suppose you look up a class in the Java API...

### Java.futile

**Class Quizzical**

```java
java.lang.Object
  java.futile.Quizzical
```

```java
public class Quizzical extends Object
```

Made-up class. It does not matter what it actually does (just trying to see if you know how to use it).

#### Method Summary

<table>
<thead>
<tr>
<th>Method Name</th>
<th>Return Type</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>doThis</code></td>
<td>String</td>
<td><code>int x, boolean y</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mystery method 1.</td>
</tr>
<tr>
<td><code>getThis</code></td>
<td>double</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mystery method 2.</td>
</tr>
</tbody>
</table>

**a) What import statement do you need in your program so as to use this class?**

**b) For each of the methods listed in the method summary, state its name, return type and the number and types of parameters it requires.**

**c) Suppose you are writing a Java program that uses Quizzical and you have already declared and instantiated objects quiz1 and quiz2. Give examples of using them to invoke the methods of this class to print something.**
7. (10 marks)
a) Write a single statement that computes the square root of the product of two numbers, num1 and num2 and assigns the result to a variable num3. Assume all variables have already been declared with type double.

b) Assuming that a Random object has been created called generator, what is the range of the result of each of the following expressions?

    generator.nextInt(8)

    generator.nextInt(5) + 8

    generator.nextInt(3) - 4
8. (_____/ 10) Suppose a variable total holds the number of pennies in your piggy bank. Write a code fragment (not a complete program) that computes the number of dollar bills and quarters that can be “made” with the pennies stored in your piggy bank (Note: we will not bother with nickels and dimes). Assume all variables have already been declared as follows and the value of total has already been obtained from the user:

```java
Scanner scan = new Scanner(System.in);
int total, dollars, quarters;
total = scan.nextInt();
```

You only need to supply the code for computing the value of dollars and quarters (do NOT write any additional code, for example to print the results).
9. (_____/ 10)

Construct an algorithm that inputs a number num and then prints “Hello” that many times. After the “Hello”s are printed, print a goodbye message.

Example: If num (i.e., the input) is 5, the algorithm should print something like this:

Hello
Hello
Hello
Hello
Hello
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.

input num
input count
count = 1
count = 0
count = count + 1
num = num + 1
if (count < num)
else
while (count <= num)
while (count != 5)
while (count <= 5)
print "Hello"
print num
print "Goodbye"
9. (_____ / 10)
Construct an algorithm that inputs 10 positive numbers and prints the maximum of these numbers.

Example: If the numbers input are 44 7 31 22 53 16 21 48 72 60, the output should be:
\[ \text{max} = 72 \]

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.

\begin{align*}
\text{num} &= 0 \\
\text{count} &= 0 \\
\text{count} &= 1 \\
\text{max} &= 0 \\
\text{count} &= \text{count} + 1 \\
\text{num} &= \text{max} \\
\text{max} &= \text{num} \\
\text{print} \ "\text{max} = " \ \text{num} \\
\text{input} \ \text{num} &\quad \text{input max} \\
\text{if} \ (\text{num} > \text{max}) &\quad \text{if} \ (\text{count} < \text{max}) \\
\text{else} &\quad \text{while} \ (\text{count} \leq 10) \\
\text{while} \ (\text{count} < 10) &\quad \text{while} \ (\text{num} < \text{max}) \\
\text{while} \ (\text{num} \neq \text{max}) &
\end{align*}
9. (_____/ 10)

Construct an algorithm that inputs a number num and prints all its factors (i.e., all the values of x in the range 2...(num-1) that such that num is divisible by x). After the factors are printed, print a goodbye message.

Example: If num (i.e., the input) is 20, the algorithm should print:

The factors of 20 are:
2 4 5 10
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
input num
input x
x = 1
x = 2
x = x + 1
if (num % x == 0)
if (num % 2 == 0)
if (num % 2 == x)
else
while (x < num)
while (x <= num)
while (num %2 == x)
while (num % 2 == 0)
print "The factors of " num " are:"
print x
print num
print "Goodbye"
```
9. (______/10)

Construct an algorithm that inputs some numbers from the user, terminated with a zero (sentinel value). The algorithm should print the numbers entered and compute and print their sum. After the sum is printed, print a goodbye message.

Example: If the numbers 5 -3 8 0 are entered as input, the algorithm should print:

```
5
-3
8
Sum = 10
Goodbye
```

[Note that the terminating zero 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 sum
num = 0
sum = 0
num = num + 1
sum = sum + 1
sum = sum + num
sum = num + 1
if (sum == num)
if (sum < num)
if (num < sum)
else
while (num < sum)
while (sum < num)
while (num != 0)
while (num != sum)
print "The factors of " num " are:"
print "Sum = " sum
print num
print "Goodbye"
```
10. (_____/ 10) Write a complete Java program that asks your first name and last name and then prints a greeting using your initials. For example, an interaction might look like this:

Please enter your first name: Grace
Please enter your last name: Hopper
Great meeting you, G.H., have a nice day.

*It is NOT necessary to include comments with your code, but be sure to use good indentation.*
10. (_____ / 10) Write a complete Java program that asks your name and then prints it out one letter per line.
For example, an interaction might look like this:

```
Please enter your name: Grace
Hello...
G
r
a
c
e
```

*It is NOT necessary to include comments with your code, but be sure to use good indentation*