CSC 1051 Algorithms and Data Structures I

Midterm Examination
October 9, 2014

Name:______________________________

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<thead>
<tr>
<th>Question</th>
<th>Value</th>
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<td>TOTAL</td>
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</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 and clearly indicate where the answer can be found. Good luck!

a) How many bits/bytes are needed to store a color picture that is 200 pixels wide and 400 pixels high under each of the following schemes? Express your answer as approximate number of KB or MB, etc., as appropriate. Show your work and fill in the answers below:

Total # pixels ______________

\[
\begin{array}{llll}
\text{Bitmap (1 bit/pixel)} & \text{Greyscale (1 byte/pixel)} & \text{RGB (3 bytes/pixel)} \\
\end{array}
\]

# bytes _____________ _____________ _____________

# bits _____________ _____________ _____________

b) List all binary codes that can be made with 3 bits

c) With \( n \) bits we can have _____________ different binary codes
2. [10/10] Refer to the program below. Next to each word in the list, choose the most fitting description:

- reserved word
- constant
- variable
- method

```java
import java.util.Scanner;

public class Age {
    // -------------------------------
    // Reads the user's age and prints comments accordingly.
    // -------------------------------
    public static void main (String[] args) {
        final int MINOR = 21;
        Scanner scan = new Scanner (System.in);
        System.out.print ("Enter your age: ");
        int age = scan.nextInt();
        System.out.println ("You entered: "+ age);
        if (age < MINOR)
            System.out.println ("Youth is a wonderful thing. Enjoy.");
        System.out.println ("Age is a state of mind.");
    }
}
```
3. [10] What output is produced by the following program?

```java
public class OneMoreTime {
    public static void main (String[] args) {
        System.out.print ("Howdy there... ");
        System.out.println ("I promise
this is the 
" + "last time"");
        System.out.print ("you have to do this ");
        System.out.println ("so
please count the " + \\
"’s carefully!");
        System.out.println ("And numbers... " + 20 + 30);
        System.out.println ("Is this different? ... " + (20 + 30));
    }
}
```

Output:

```
Howdy there... 
I promise
this is the 
"last time"

you have to do this 
so
please count the "’s carefully!

And numbers... 50
Is this different? ... 50
```

b) Write a single `println` statement that would output

```
"Hello"
"Goodbye"
```
Given the following declarations:

```java
int iResult, num1 = 7, num2 = 3;
double fResult, val1 = 9.0;
boolean status, part1 = false;
```

What result is stored by each of the following assignment statements?

<table>
<thead>
<tr>
<th>Source code</th>
<th>Result stored</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>fResult = (num1 + 2)/ 2;</code></td>
<td></td>
</tr>
<tr>
<td><code>iResult = num1 % num2;</code></td>
<td></td>
</tr>
<tr>
<td><code>fResult = val1 / 2;</code></td>
<td></td>
</tr>
<tr>
<td><code>fResult = (double) num1 / 2;</code></td>
<td></td>
</tr>
<tr>
<td><code>status = part1 &amp;&amp; (num1 &gt; num2);</code></td>
<td></td>
</tr>
<tr>
<td>`status = part1</td>
<td></td>
</tr>
</tbody>
</table>
5. [10] Below is the code for the Snowman applet and the image it produces.

a) Sketch the image produced by modifying the code indicated by the arrow, as follows:

```java
final int TOP = 20;
```

b) Add some code to the program below to make the snowman look like he is holding a green ball, i.e.:

- add a “hand” – 10 pixel long horizontal line, start at arm
- add a green ball, 10 by 10 pixels, resting on the hand.
- be sure the ball is green, but the hand is black
- see illustration below

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

public class Snowman extends JApplet {
    public void paint(Graphics page) {
        final int MID = 150;
        final int TOP = 50;

        page.setColor(Color.cyan);
        page.fillRect(0, 0, 300, 175); // sky
        page.setColor(Color.blue);
        page.fillRect(0, 175, 300, 50); // ground
        page.setColor(Color.yellow);
        page.fillOval(-40, -40, 80, 80); // sun

        page.setColor(Color.white);
        page.fillOval(MID-20, TOP, 40, 40); // head
        page.fillOval(MID-35, TOP+35, 70, 50); // upper torso
        page.fillOval(MID-50, TOP+80, 100, 60); // lower torso

        page.setColor(Color.black);
        page.fillOval(MID-10, TOP+10, 5, 5); // left eye
        page.fillOval(MID+5, TOP+10, 5, 5); // right eye

        page.drawArc(MID-10, TOP+20, 20, 10, 190, 160); // smile

        page.drawLine(MID-25, TOP+60, MID-50, TOP+40); // left arm
        page.drawLine(MID+25, TOP+60, MID+55, TOP+60); // right arm

        page.drawLine(MID-20, TOP+5, MID+20, TOP+5); // brim of hat
        page.fillRect(MID-15, TOP-20, 30, 25); // top of hat

        //*** code for left hand holding green ball goes here ***
    }
}
```
6. [ / 10] What gets printed?

Please show output as it will appear or indicate “NO OUTPUT” or “INFINITE LOOP.”

```java
int a = 4;
while (a > 0)
{
    System.out.println(a);
    a++;
}
```

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

```java
int a = 4;
while (a > 0)
{
    System.out.println(a);
    a = a - 2;
}
```

Output:
```
4
2
```

```java
int a = 1;
while (a < 4)
{
    a++;
    System.out.println(a);
}
```

Output:
```
1
2
3
```

```java
int a = 4;
while (a < 4)
{
    System.out.println (a);
    a++;
}
```

Output:
```
4
3
2
1
```

7. [ / 10] Let’s look at the problem of repeatedly obtaining input and performing a calculation, for example, computing the area of a circle given its radius, using the following algorithm:

<table>
<thead>
<tr>
<th>Variables:</th>
<th></th>
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<tbody>
<tr>
<td>radius, area</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Algorithm:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>input radius</td>
<td></td>
</tr>
<tr>
<td>area = radius<em>radius</em> PI</td>
<td></td>
</tr>
<tr>
<td>print area</td>
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</table>

Rewrite this algorithm, modifying it so that it uses a while structure to repeat the processing of each input in two different ways.

a) Compute the areas of 5 circles (exact count).

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b) Keep computing circle areas until user inputs -1 for the radius (sentinel value)

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<tr>
<th>Algorithm:</th>
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</table>
8. [ / 10] Suppose you look up a method in the Java API and find this method heading:

```java
void getThisDone(String x, double y)
```

(a) Fill in the following information about this method:

| Method name: | ____________________________ |
| Method return type: | __________ |
| Required parameters for the method: (how many? of what type(s)?) | ____________________________________________________________________ |

(b) Suppose this method is defined in class `Midterm` and you have an object `mid1` of that class. Give an example of the use of the dot operator to invoke this method. (Hint: You need to use `Midterm` or `mid1` but not both.)
9. [ / 10]

a) Suppose the String variable message is already initialized. Write a Java code fragment that prints out message, backwards.

b) Write some code that uses the Math class to compute and print out the value of \( \cos(\pi/2) \).

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

d) Write an expression using the nextInt method that generates random numbers in the range 1 to 1000, including the endpoints. Use the version of the nextInt method that accepts a single integer parameter.
10. (______/ 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.

```
num = 0
input max
count =0
input count
count = 1
if (num > max)
max = 0
if (count < max)
count = count + 1
else
num = max
while (count <= 10)
max = num
while (count < 10)
print "max = " max
while (num < max)
input num
while (num !=max)
```
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);
```

Drawing an Arc

* An arc is defined by an oval, a start angle, and an arc angle:
Random class

```java
double nextDouble()
Returns the next pseudorandom, uniformly distributed double value between 0.0 and 1.0
```

```java
int nextInt()
Returns the next pseudorandom, uniformly distributed int value from this random number generator's sequence.
```

```java
int nextInt(int n)
Returns a pseudorandom, uniformly distributed int value between 0 (inclusive) and the specified value (exclusive), drawn from this random number generator's sequence.
```

Some methods of the Math class

```java
static double abs(double a)
Returns the absolute value of a double value.
```

```java
static double cos(double a)
Returns the trigonometric cosine of an angle.
```

```java
static double pow(double a, double b)
Returns the value of the first argument raised to the power of the second argument.
```

```java
static double random()
Returns a double value greater than or equal to 0.0 and less than 1.0.
```

```java
static long round(double a)
Returns the closest long to the argument.
```

```java
static double sin(double a)
Returns the trigonometric sine of an angle.
```

```java
static double sqrt(double a)
Returns the correctly rounded positive square root of a double value.
```

String class

```java
boolean isEmpty()
Returns true if, and only if, length() is 0.
```

```java
char charAt(int index)
Returns the char value at the specified index.
```

```java
int length()
Returns the length of this string.
```

```java
String toUpperCase()
Converts all of the characters in this String to upper case using the rules of the default locale.
```