CSC 1051 Algorithms and Data Structures I

Midterm Examination
February 24, 2014

Name: ______ KEY 1

<table>
<thead>
<tr>
<th>Question</th>
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<td><strong>TOTAL</strong></td>
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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!
1. [/10] Short answer questions.

a) Recall that RGB images use one byte to represent each of the primary color components of each pixel. Using this scheme, approximately how many megabytes are required to represent a picture that is 3000 pixels across and 1000 pixels high?
   Explain.

   \[ 3000 \times 1000 \times 3 = 9 \text{ MB} \]

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

   000
   010
   011
   001
   111
   100
   101
   110

c) What does RAM stand for? How does it differ from ROM?

   Random Access Memory – RAM can be changed; ROM is read-only and comparatively very small

d) Whitespace (i.e., blanks, tabs, new lines) are generally ignored by the Java compiler almost everywhere… except when they are part of a … :
   1. comment
   2. String
   3. compound statement inside a while loop
   4. the start of an if/else
   5. variable name

   (circle all that apply)
2. [ /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] Short answer questions.

a) A physics student gets unexpected results when using the code:

\[ F = \frac{G \times \text{mass1} \times \text{mass2}}{(r \times r)}; \]

to compute values according to the formula \( F = \frac{G m_1 m_2}{r^2}. \)

Explain the problem and correct the code.

**Enforce precedence using ()**

b) The code below is supposed to print the numbers from 1 to 10, but it has an error.

```java
int count = 1;
while (count <= 10)
    System.out.println (count);
    count++;
```

i) Describe the error and how to correct it?

**Missing Braces**

ii) If the error is not corrected, what, if anything gets printed?

**1 is infinitely printed**

iii) Is this a syntax, runtime, or logical error? **Logical**
4. [ /10] The following program is supposed to determine whether a positive integer `myNum` is prime (i.e., has no divisors other than 1 and itself). It does this by checking if any values `n` are divisors, using a boolean variable `gotIt` to keep track of whether a divisor has been found.

```java
import java.util.Scanner;
public class PrimeTester {
    public static void main (String[] args) {
        Scanner scan = new Scanner (System.in);
        System.out.println("Please enter a positive integer.");
        int myNum = scan.nextInt();

        int n = 2;
        boolean gotIt = false;

        System.out.print ("This number is ");
        if (gotIt) System.out.print ("NOT ");
        System.out.println ("prime.");
    }
}
```

a) Which of these versions of the code should go in the box above? (circle correct one)

```java
while (n < myNum) {
    if (myNum % n == 0) gotIt = true;
    else gotIt = false;
    n++;
}
```

```Java
while (n <= myNum) {
    if (myNum % n == 0) gotIt = true;
    else gotIt = false;
    n++;
}
```

```Java
while (n <= myNum) {
    if (myNum % n == 0) gotIt = true;
    n++;
}
```

b) Show the output produced by the program, given to the following inputs:

- 23 ______ This number is prime
- 15 ______ This number is NOT prime
- 2 ______ This number is prime
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:

```
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 ***

        page.drawLine (MID-60, TOP+40, MID-50, TOP+40); // left hand
        page.setColor (Color.red);
        page.fillOval (MID-60, TOP+30, 10, 10); // red ball in hand
    }
}
```
6. [ /10] What gets printed by the following program?

```java
// Guess what this does
class Midterm {
    public static void main(String args[]) {
        int x = 10;
        int a = 20;
        int b = 30;
        x = a;
        a = b;
        b = 40;

        String mood = "happy";

        System.out.println(" Welcome to the \nMidterm \"experience\"");
        System.out.println(" x = " + x + " a = " + a + " b = " + b);
        System.out.println(" and this: " + (2 + 3));
        System.out.println(" Try this: " + 2 + 3);
        System.out.println(" and this also: " + "2 + 3");
        System.out.println(" This is a " + mood + " " + mood + " day!");
    }
}
```

Output

Welcome to the Midterm "experience"
x = 20 a = 30 b = 40
and this: 5 Try this: 23 and this also: 2+3
This is a happy happy day!
7. [10] Given the following declarations:

```java
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>double</td>
<td>int -&gt; d (automatic)</td>
</tr>
<tr>
<td><code>fResult = (double) num1 / num2;</code></td>
<td>2.5</td>
<td>double</td>
<td>num1 -&gt; cast (Widening) num2 -&gt; automatic (Widening)</td>
</tr>
<tr>
<td><code>iResult = (int) val1;</code></td>
<td>8</td>
<td>int</td>
<td>cast -&gt; int</td>
</tr>
<tr>
<td><code>fResult = (double)(num1 / num2);</code></td>
<td>2.0</td>
<td>double</td>
<td>cast -&gt; double</td>
</tr>
</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 = 6;
while (a < 8)
{
    a++;
    System.out.println(a);
}
```

Output: 7

```
int a = 6;
while (a < 8)
{
    System.out.println(a);
    a--;
}
```

Output: infinite Loop

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

Output: 6

```
int a = 6;
while (a < 7)
{
    System.out.println (a);
    a++;
}
```

Output: 6
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”
```

```
input num
count = 0
while (count < num)
    print "Hello"
    count = count + 1
print "Goodbye"
```
10. (______/ 10) Write a complete Java program that asks the user to input a value representing a number of seconds, and then prints the equivalent amount of time as a combination of hours, minutes, and seconds. (For example, 9999 seconds is equivalent to 2 hours, 46 minutes and 39 seconds.)

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.

```java
import java.util.Scanner;

public class Seconds {
    public static void main(String[] args) {
        Scanner scan = new Scanner(System.in);
        int seconds = scan.nextInt();

        int hours = seconds / 3600;
        seconds = seconds - (hours * 3600);
        int min = seconds / 60;
        seconds = seconds - (min * 60);

        System.out.print(hours + " " + min + " " + seconds);
    }
}
```
CSC 1051 Algorithms and Data Structures I

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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!*

e) Recall that RGB images use one byte to represent each of the primary color components of each pixel. Using this scheme, approximately how many megabytes are required to represent a picture that is 3000 pixels across and 1000 pixels high?
   **Explain.**

   \[3000 \times 1000 \times 3 = 9 \text{ MB} \]

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

   000
   010
   011
   001
   111
   100
   101
   110

g) What does RAM stand for? How does it differ from ROM?

   **Random Access Memory** – RAM can be changed; ROM is read-only and comparatively very small

h) Whitespace (i.e., blanks, tabs, new lines) are generally ignored by the Java compiler almost everywhere… **except** when they are part of a … :

   6. comment
   7. String
   8. compound statement inside a while loop
   9. the start of an if/else
   10. variable name
2. [ /10] Refer to the program below. Next to each word in the list, choose the most fitting description:

- reserved word
- constant
- variable
- method

nextInt [Method] if [Reserved Word]

scan [Variable] println [Method]

import [Reserved Word] public [Reserved Word]

MINOR [Constant] class [Reserved Word]

age [Variable] int [Reserved Word]

```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] Short answer questions.

a) A physics student gets unexpected results when using the code:

\[ F = \frac{G \times \text{mass1} \times \text{mass2}}{(r \times r)}; \]

to compute values according to the formula \( F = \frac{G m_1 m_2}{r^2} \).

Explain the problem and correct the code.

**Enforce precedence using ( )**

b) The code below is supposed to print the numbers from 1 to 10, but it has an error.

```java
int count = 1;
while (count <= 10); {
    System.out.println (count);
    count++;
}
```

i) Describe the error and how to correct it?

**Incorrect semicolon after while**

ii) If the error is not corrected, what, if anything gets printed?

**Nothing infinite loop**

iii) Is this a syntax, runtime, or logical error? **Logic**
4. [ /10] The following program is supposed to determine whether a positive integer myNum is prime (i.e., has no divisors other than 1 and itself). It does this by checking if any values n are divisors, using a boolean variable gotIt to keep track of whether a divisor has been found.

```java
import java.util.Scanner;
public class PrimeTester
{
    public static void main (String[] args)
    {
        Scanner scan = new Scanner (System.in);
        System.out.println("Please enter a positive integer.");
        int myNum = scan.nextInt();

        int n = 2;
        boolean gotIt = false;

        System.out.print ("This number is ");
        if (gotIt)
            System.out.print ("NOT ");
        System.out.println ("prime.");
    }
}
```

a) Which of these versions of the code should go in the box above? (circle correct one)

```java
while (n <= myNum)
{
    if (myNum % n == 0)
        gotIt = true;
    else  gotIt = false;
    n++;
}
```

```java
while (n < myNum)
{
    if (myNum % n == 0)
        gotIt = true;
    else  gotIt = false;
    n++;
}
```

b) Show the output produced by the program, given to the following inputs:

- 33  ____This number is NOT prime
- 13  ____This number is prime
- 1   ____This number is prime
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 MID = 50;
```

b) Add some code to the program below to make the snowman look like he is holding a red ball, i.e.:
- add a “hand” – 10 pixel long horizontal line, start at arm
- add a red ball, 10 by 10 pixels, resting on the hand.
- be sure the ball is red, 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 red ball goes here ***
        page.drawLine(MID-60, TOP+40, MID-50, TOP+40); // left hand
        page.setColor(Color.red);
        page.fillOval(MID-60, TOP+30, 10, 10); // red ball in hand
    }
}
```
6. [ /10] What gets printed by the following program?

```java
// Guess what this does
public class Midterm {
    public static void main(String args[]) {
        int x = 1;
        int a = 2;
        int b = 3;
        x = a;
        a = b;
        b = 4;

        String mood = "happy";

        System.out.println(" Welcome to the Midterm " + mood + " experience");
        System.out.println(" x = " + x + " a = " + a + " b = " + b);

        System.out.println(" Try this: " + 2 + 3);
        System.out.println(" and this: " + (2 + 3));
        System.out.println(" and this also: " + 2 + 3);

        System.out.println(" This is a " + mood + " " + mood + " day!");
    }
}
```

**Output**

```
Welcome to the
Midterm "experience"
x = 2 a = 3 b = 4
Try this: 23 and this: 5 and this also: 2+3
This is a happy happy day!
```
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.

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<td>Int -&gt; double automatic</td>
</tr>
<tr>
<td>fResult = (double) num1 / num2;</td>
<td>2.5</td>
<td>double</td>
<td>Num1 – Cast (Widening)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Num2 – Automatic</td>
</tr>
<tr>
<td>iResult = val1;</td>
<td>ERROR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fResult = (double) (num1 / num2);</td>
<td>2.0</td>
<td>double</td>
<td>num1/num2 none cast to double widening</td>
</tr>
</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 = 5;
while (a < 8) {
    a++;
    System.out.println(a);
}
```

Output: 6
    7
    8

```java
int a = 5;
while (a < 8) {
    System.out.println(a);
    a--;
}
```

Output: infinite loop

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

Output: 5
    3
    1

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

Output:No Output
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.

```plaintext
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”
```

```plaintext
input num
count = 1
while (count <= num)
   print "Hello"
   count = count +1
print "Goodbye"
```
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.

```java
import java.util.Scanner;

class Days {
    public static void main(String[] args) {
        Scanner scan = new Scanner(System.in);
        int days = scan.nextInt();
        int weeks = days / 7;
        days = days % 7;
        System.out.println(weeks + " " + days);
    }
}
```