# CSC 1051 Algorithms and Data Structures I

## Midterm Examination

**February 24, 2014**

**Name:**

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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.

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

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

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)
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:

   \[ F = G \times \text{mass1} \times \text{mass2} / r \times r; \]

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

   Explain the problem and correct the code.

   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?

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

   iii) Is this a syntax, runtime, or logical error? __________
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.");
    }
}
```

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

• 23

• 15

• 2

Note: The differences are the "<" vs. "\leq" and the if/else vs. just if (no else)
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 by the following program?

```java
// Guess what this does
public 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*
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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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);
}
```

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

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

```java
int a = 6;
while (a < 7) {
    System.out.println (a);
    a++;
}
```
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"
```
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.
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!
1. [ /10] Short answer questions.

   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.**

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

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

   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

   (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:

\[ F = G \times \text{mass1} \times \text{mass2} / r \times r; \]

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

Explain the problem and correct the code.

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?

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

iii) Is this a syntax, runtime, or logical error? _________
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)
    while (n <= myNum)
    {
        if (myNum % n == 0)
            gotIt = true;
        else  gotIt = false;
        n++;
    }
    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
    • 13
    • 1
    Note: The differences are the "<" vs. "<=" and the if/else vs. just if (no else)
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 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 ***
    }
}
```
6. [ /10] What gets printed by the following program?

// 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 \nMidterm \"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*
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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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:

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

Output:

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

Output:

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

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.

```
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"
```
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.
import java.util.Scanner;

public class Example {
    // prints an intro message

    public static void main (String[] args) {
        int age = 18;
        String name = "";
        String petName = "";
        Scanner scan = new Scanner(System.in);

        System.out.println("Please enter name: ");
        name = scan.nextLine();

        System.out.println("Please enter pet name: ");
        petName = scan.nextLine();

        System.out.println("Please enter age: ");
        age = scan.nextInt();

        System.out.println("Hello, my name is " + name);
        System.out.println("I am " + age);
        System.out.println("My pet, " + petName);
        System.out.println(" is impressed with my knowledge of Java!");
    }
}