Name (as in matriculation card): ________________________________

Discussion Group: ____                      Score: ______

Instructions:
1. Write your name (as in your matriculation card) and discussion group above.
2. This is an open-book test.
3. Please note that the papers are different for CS1101X, CS1101Y and CS1101Z. Check that you get the right paper.
4. The duration of the test is 1 hour 15 minutes.
5. Calculators are allowed, but not laptops, PDAs or other computing devices.
6. This paper consists of eight (8) printed pages and seventeen (17) questions. Maximum mark is 30.
7. You may use pencil to write codes, but pen is preferred for other questions. Write legibly or risk losing marks.
8. Answer all questions. Write your answers in this question paper.
For questions 1 – 10, write your answer in CAPITAL letter (A, B, C, D, E) on the line provided. One mark is awarded for each correct answer.

1. Which of the following methods of the String class is used to access the character at a specific position in a string?
   A. charAt( )
   B. substring( )
   C. valueOf( )
   D. indexOf( )
   E. pos( ) Answer: ______

2. How would we translate “any two-digit number from 00 to 39” into a regular expression?
   A. [00-39]
   B. [0][0][3][9]
   C. [00]-[39]
   D. [0-3][0-9]
   E. [40-01] Answer: ______

3. In the worst case, roughly how many comparisons are needed to search for a value in a sorted array with 2000 elements using binary search?
   A. 2000
   B. 45
   C. 20
   D. 12
   E. 6 Answer: ______

4. What is the output of the following code fragment?

   ```java
   int x, y, z;
   y = 1; z = 0;
   for (x = 5; x < 10; x++) {
     y *= 2;
     if (x > y) z++;
   }
   System.out.println("" + x + "" + y + "" + z);
   ```

   A. 9 16 5
   B. 9 32 5
   C. 10 16 3
   D. 9 32 2
   E. 10 32 2 Answer: ______
5. In the recursive method for the Tower of Hanoi problem, what is the number of moves required to move a tower of $N$ discs from one pole to the other?

   A. $N^2$
   B. $2^N$
   C. $2^{N-1}$
   D. $2^N - 1$
   E. $N^N$

   Answer: _____

6. Given an integer array with 6 elements shown below, how does the array look like after the first pass in Bubble sort to sort the elements in ascending order?

   5, 3, 25, 21, 17, 10

   A. 5, 3, 25, 21, 17, 10
   B. 3, 5, 21, 25, 10, 17
   C. 25, 21, 17, 10, 5, 3
   D. 3, 5, 21, 17, 10, 25
   E. 3, 5, 10, 17, 21, 25

   Answer: _____

For Questions 7 to 11, refer to the following class definitions in the same file:

```java
import java.awt.*;

class LineSegment {
    protected Point p1;
    protected Point p2;

    // default constructor
    public LineSegment() {
        p1 = new Point();
        p2 = new Point();
    }

    // alternate constructor
    public LineSegment(Point p1, Point p2) {
        this.p1 = p1;
        this.p2 = p2;
    }

    public String toString() {
        return "[" + p1 + "", " + p2 + "]";
    }
}
```
class ThickLineSegment extends LineSegment {
    private double thickness;

    // default constructor
    public ThickLineSegment() {
        thickness = 0.25;
    }

    // alternate constructor
    public ThickLineSegment(LineSegment s, double t) {
        super(s.p1, s.p2);
        thickness = t;
    }
}

class TestMain {
    public static void main (String[] args) {
        ThickLineSegment myLine1 = new ThickLineSegment();
        ThickLineSegment myLine2 = new ThickLineSegment(<to be filled>);
        LineSegment myLine3 = myLine1;
        System.out.println(myLine1);
    }
}

7. Which of the following statements is true?
   A. The attributes p1 and p2 of LineSegment class must be private.
   B. The default constructor for LineSegment creates a line segment with two null points.
   C. The method getClass() must be used in the toString() method for LineSegment.
   D. The method super() must appear in the default constructor for ThickLineSegment.
   E. None of the above. Answer: _____

8. Is myLine3 an instance of the LineSegment class? Is it an instance of the ThickLineSegment class?
   A. No; No.
   B. No; Yes.
   C. Yes, No.
   D. Yes; Yes.
   E. myLine3 will not be created as it is an error. Answer: _____
9. What is the output of the program?
   A. `[java.awt.Point[x=0, y=0], java.awt.Point[x=0, y=0]]`
   B. `[java.awt.Point(x=0, y=0), java.awt.Point(x=0, y=0)]`
   C. `[java.awt.Point[x=0, y=0], java.awt.Point[x=0, y=0], 0.25]`
   D. `[java.awt.Point(x=0, y=0), java.awt.Point(x=0, y=0), 0.25]`
   E. Error

   Answer: _____

10. If you want to assign the points (1,2) and (3,4) to `myLine2`, and thickness of 1.5 to it, which of the following may be used in the <to be filled> portion?
   A. `new Point(1,2), new Point(3,4), 1.5`
   B. `new LineSegment(new Point(1,2), new Point(3,4)), 1.5`
   C. `new LineSegment(Point(1,2), Point(3,4)), 1.5`
   D. `Point(1,2), Point(3,4), 1.5`
   E. `(1,2), (3,4), 1.5`

   Answer: _____

11. Suppose an accessor `getThickness()` has been added for the `ThickLineSegment` class, and you have created an array of `ThickLineSegment` objects in your main method. The array contains at least one element.

   Write a method `thickest` to return the index of the thickest line segment in the array. If there are more than one line segment with the same largest thickness, you are to return the biggest index among them. For example, if the array contains 5 line segments with these thicknesses: 1.2, 3.4, 1.2, 3.4, 0.5, the method should return the value 3.

   [5 marks]
12. Given that the following command takes two inline arguments: an input filename “data” and an output filename “output”:

```
java CopyFile data output
```

Shown below is the partial code for CopyFile.java. Fill in the box. [2 marks]

```
import java.io.*;

public class CopyFile {
    public static void main (String[] args) {
        // Create File objects
        File inFile = ...
        File outFile = ...
    }
}
```

13. Given the following program, what is the output? [2 marks]

```
class Program1 {
    public static void main (String[] args) {
        int[] array = aMethod(12);
        printArray(array);
    }

    public static int[] aMethod (int n) {
        int[] arr = new int[n];
        for (int i = 0; i < n; ++i) {
            for (int j = 0; j <= i; ++j) {
                arr[j]++;
            }
        }
        return arr;
    }

    public static void printArray (int[] arr) {
        for (int i = 0; i < arr.length; ++i) {
            System.out.print(arr[i] + " ");
        }
        System.out.println();
    }
}
```

Answer: __________________________________________
14. If `aMethod` in Question 13 above is replaced by the method below, what is the output of the program? [2 marks]

```java
class Main {
    public static int[] aMethod (int n) {
        int[] arr = new int[n];
        for (int i = 0; i < n; ++i) {
            int count = 0;
            for (int j = 0; j <= i; ++j) {
                for (int k = j; k < i; ++k) {
                    count++;
                }
            }
            arr[i] = count;
        }
        return arr;
    }
}
```

Answer: _______________________________________

15. The `aMethod` in Question 14 above is inefficient. Rewrite the method by removing as many loops as possible, and use only add operation, not multiplication or division.

Write your method in the box below: [5 marks]

```java
public static int[] aMethodOptimized (int n) {
    int[] arr = new int[n];
    for (int i = 0; i < n; ++i) {
        int count = 0;
        for (int j = 0; j <= i; ++j) {
            count += i - j;
        }
        arr[i] = count;
    }
    return arr;
}
```
16. Given the following recursive method \( f(\text{int} \ a) \), what is the value returned by \( f(123456789) \)?

\[
\text{public static int } f \ (\text{int} \ a) \ \{ \\
\quad \text{if} \ (a < 10) \\
\quad \quad \text{return} \ a; \\
\quad \text{else} \\
\quad \quad \text{return} \ f(a/10) + a\%10; \\
\}\n\]

Answer: ________________

17. Given the following recursive method \( g(\text{int} \ a) \), what is the value returned by \( g(12345) \)?

\[
\text{public static int } g \ (\text{int} \ a) \ \{ \\
\quad \text{if} \ (a == 0) \\
\quad \quad \text{return} \ 0; \\
\quad \text{else} \\
\quad \quad \text{return} \ g(a/3) + 1; \\
\}\n\]

Answer: ________________

--- THE END ---