Name (print): ________________________________

- **INSTRUCTIONS:**
  - Keep your eyes on your own paper and do your best to prevent anyone else from seeing your work.
  - Do NOT communicate with anyone other than the professor/proctor for ANY reason in ANY language in ANY manner.
  - This exam is closed notes, closed books, and no calculator.
  - Turn all mobile devices off and put them away now. You cannot have them on your desk.
  - Write neatly and clearly indicate your answers. What I cannot read, I will assume to be incorrect.
  - Stop writing when told to do so at the end of the exam. I will take 5 points off your exam if I have to tell you multiple times.
  - Academic misconduct will not be tolerated. Suspected academic misconduct will be immediately referred to the Emory Honor Council. Penalties for misconduct will be a zero on this exam, an F grade in the course, and/or other disciplinary action that may be applied by the Emory Honor Council.

- **TIME:** This exam has 6 questions on 12 pages including the title page. Please check to make sure all pages are included. You will have 50 minutes to complete this exam.

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*I commit to uphold the ideals of honor and integrity by refusing to betray the trust bestowed upon me as a member of the Emory community. I have also read and understand the requirements and policies outlined above.*

Signature: _____________________________________________________

<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>16</td>
<td>14</td>
<td>18</td>
<td>18</td>
<td>14</td>
<td>20</td>
<td>100</td>
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<tr>
<td>Score</td>
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</tbody>
</table>


1. (16 points) For each entry below, state whether the code is correct, or has an error. If there is no error, write the output. If there is a syntax error or a runtime error, show where the error is (you can circle the incorrect code) and explain why it is an error.

The following variables were initialized for you:

```java
String s1 = "exam2";
int[] a1 = {5, 2, 3, 1, 4};
String[] a2 = {"attitude", "hard"};
```

(a) `System.out.println(a1[s1.length()]);`

```
(b) System.out.println(a1[a2.length]);
```

(c) `System.out.println( a1[a2[1].length()] );`

(d) `System.out.println(a1[s1.length()-1]);`

(e) `System.out.println(s1.charAt(a1[1]));`
(f) System.out.println( s1.charAt(a2.length) );

(g) System.out.println( a2[ (int) s1.charAt(4) ] );

(h) System.out.println( a2[0].charAt(a1[ s1.length()- 3 ] ) );
2. Draw the array $A$ that would result after the following code is executed.

(a) (4 points)
$$\text{char[]} \ B = \{ 'r', 'e', 'd', 'r', 'u', 'm' \};$$
$$\text{char[]} \ A = \text{new char[ B.length ]};$$
$$\text{for (int i = B.length -1; i >= 0; i--)}\{$$
  \text{int j = B.length - i;}
  \text{A[i] = B[j-1];}
\}\$$

(b) (5 points)
$$\text{int[]} \ A = \{ 1, 2, 3, 5, 8, 13 \};$$
$$\text{for (int i=0; i < A.length-1; i++)}\{$$
  \text{int j = A.length - i - 1;}
  \text{int temp=A[i];}
  \text{A[i]=A[j];}
  \text{A[j]=temp;}
\}\$$

(c) (5 points)
$$\text{int[]} \ A = \{ 1, 2, 3, 5, 8, 13 \};$$
$$\text{for (int i=0; i < A.length-1; i++)}\{$$
  \text{int temp=A[i];}
  \text{A[i]=A[i+1];}
  \text{A[i+1]=temp;}
\}\$$
3. Read the following Java code. Then answer the questions.

```java
public class Q3{
    public static double minScore = 70.0; //position (1)

    public static void curveAddPoint(double minScore, double addPoint){
        minScore += addPoint;
    }

    public static void curveAddPoint(double[] minScore, double addPoint){
        for(int i=0; i<minScore.length; i++)
            minScore[i] += addPoint;
    }

    public static boolean isFailed(double minScore){ //position (2)
        return minScore < Q3.minScore;
    }

    public static boolean isFailed(double[] minScore){ //position (3)
        double min = minScore[0];
        for(int i = 1; i<minScore.length; i++){
            if( min > minScore[i] )
                min = minScore[i];
        }
        return min < Q3.minScore;
    }

    public static void main(String[] args){
        double[] myRawScore = {60.0, 75.0, 85.0};

        curveAddPoint(myRawScore, 5);
        double minScore = myRawScore[0]; //position (4)
        System.out.println(minScore);
        if(isFailed(myRawScore))
            System.out.println("Fail!");
        else
            System.out.println("Pass!");

        curveAddPoint(myRawScore[0], 10);
        minScore=myRawScore[0];
        System.out.println(minScore);
        if(isFailed(myRawScore[0]))
            System.out.println("Fail!");
        else
            System.out.println("Pass!");
    }
}
```
(a) (4 points) Write down the variable type of the following variables in the above program (Class variable, Local variable or Parameter variable)

minScore at position (1):

minScore at position (2):

minScore at position (3):

minScore at position (4):

(b) (1 point) What is the input datatype of method isFailed(double[] minScore)?

(c) (1 point) What does the method isFailed(double[] minScore) do?

(d) (12 points) What is the output of this program?
4. Consider the following array \{4, 2, 11, 1, 9, 6, 7\}

(a) (3 points) Write out the values in the list that will be inspected during a **linear search** for the value 9.

(b) (6 points) The 2 sets of list below show the sequence of a list of numbers when it is sorted using one of the sorting algorithms we studied. Steps that have no changes to the arrays are being omitted. For each set of lists, label the name of the sorting algorithm after each set.

\[
\begin{align*}
\text{begin: } & \{4, 2, 11, 1, 9, 6, 7\} \\
\text{Step 1: } & \{2, 4, 11, 1, 9, 6, 7\} \\
\text{Step 2: } & \{1, 2, 4, 11, 9, 6, 7\} \\
\text{Step 3: } & \{1, 2, 4, 9, 11, 6, 7\} \\
\text{Step 4: } & \{1, 2, 4, 6, 9, 11, 7\} \\
\text{Step 5: } & \{1, 2, 4, 6, 7, 9, 11\}
\end{align*}
\]

**Sorting algorithm**

\[
\begin{align*}
\text{begin: } & \{4, 2, 11, 1, 9, 6, 7\} \\
\text{Step 1: } & \{1, 2, 11, 4, 9, 6, 7\} \\
\text{Step 2: } & \{1, 2, 4, 11, 9, 6, 7\} \\
\text{Step 3: } & \{1, 2, 4, 6, 9, 11, 7\} \\
\text{Step 4: } & \{1, 2, 4, 6, 7, 11, 9\} \\
\text{Step 5: } & \{1, 2, 4, 6, 7, 9, 11\}
\end{align*}
\]

**Sorting algorithm**
(c) (6 points) Now we can apply binary search for a value on the current sorted array
\{1, 2, 4, 6, 7, 9, 11\}
Please write out the values that will be inspected during a binary search for the key 8.

(d) (3 points) What is the return value of searching for key 8?
5. (14 points) The quiz scores for each student are represented in an array. Your job is to write a method to calculate the Final Quiz Score from the array. The rule to calculate the Final Quiz Score is listed below:

- drop the highest score;
- drop the lowest score;
- calculate the average score for the rest of scores

For example, we have an array showing scores in 8 quizzes.

double[] scores = {10, 9.5, 9.5, 9, 9, 8.5, 8.5, 0};

The highest score is 10; the lowest score is 0; So the Final Quiz Score for this student should be \((9.5 + 9.5 + 9 + 9 + 8.5 + 8.5)/6 = 9.0\).

If there are multiple highest scores, just drop one of them. Similarly, if there are multiple lowest scores, just drop one of them.
The length of array is not fixed. The header of this method is provided for you.

```java
public static double finalScore(double[] rawScore){
    double avg = 0.0;
    // ******** WRITE YOUR CODE BELOW ********
    return avg;
}
```
6. Image enhancement techniques are widely used in clinical environment. You are working with doctors from Emory Hospital on one of their CT scan image enhancement projects. One grey-scale CT scan image can be represented as a 2D-array, with digit values as the intensity of black color.

One important step for image enhancement is to identify the color range of the image. In the 2D-array, the largest value represents the brightest pixel; the smallest value represents the darkest pixel.

Please read the user-defined method below, and answer the following questions.

```java
public static double[] colorRange(double[][] img){
    double max = img[0][0];
    double min = img[0][0];

    for(int i=0; i<img.length; i++){
        for(int j=i; j<img[i].length; j++){
            if( max < img[i][j] )
                max = img[i][j];
            if( min > img[i][j] )
                min = img[i][j];
        }
    }
    double[] range = { min, max }; 
    return range;
}
```

(a) (1 point) What is the datatype of input parameter for method `colorRange()`?

(b) (1 point) What is the datatype of the return value from method `colorRange()`?

(c) (1 point) Suppose the color value for white is 255; and the color value for black is 0. If we create an empty 2D-array as a blank image:
   ```java
double[][] blank = new double [60][60];
```
   what is the returning value(s) if we call: `colorRange( blank );` ?

(d) (3 points) After using this method for a while, the doctors discover that there is an logic error in this method. It seems that this method can only scan half of the input image. Could you help the doctors to debug? Circle on the codes for the error part, and briefly describe how to fix it.
(e) (14 points) Horizontal flip is one common image transformation, which will result in a mirror reflection of the original image. Please write a method, which will keep the row orders, but reverse the columns in each row. For example:

<table>
<thead>
<tr>
<th>1 2 3</th>
<th>3 2 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 5 6</td>
<td>6 5 4</td>
</tr>
<tr>
<td>7 8 9</td>
<td>9 8 7</td>
</tr>
</tbody>
</table>

Partial codes are given below.

```java
public static void hFlip(double[][] img){
    // ******** WRITE YOUR CODE BELOW ********

    // ******** WRITE YOUR CODE ABOVE ********
}
```