• **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 5 questions on 10 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>
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<tbody>
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</table>
1. For each of the code fragments below, give the output. If there is no output generated, you may write “none”. If the code has syntax or runtime errors, you should identify ALL of them.

(a) (2 points)
```java
public static void main(String[] args) {
    foo(1, 2);
    foo(1, 2.0);
}

public static void foo(int a, int b){
    System.out.println("F1");
}

public static void foo(double a, double b) {
    System.out.println("F2");
}
```

Solution:
F1
F2

(b) (4 points)
```java
public static void main(String[] args) {
    int num1 = 1, num2 = 2;
    swap(num1, num2);
    System.out.println(num1);
    System.out.println(num2);
    int[] num = { 1, 2 };
    swap(num);
    System.out.println(num[0]);
    System.out.println(num[1]);
}

public static void swap(int... num) {
    int tmp = num[0];
    num[0] = num[1];
    num[1] = tmp;
}
```

Solution:
1
2
2
1
(c) (4 points)
    public static void main(String[] args) {
        char[] arr1 = { 'a', 'b', 'c' }, arr2 = { 'd', 'e' };
        arr2 = arr1;
        foo(arr1);
        for (int i = 0; i < arr2.length; i++)
            System.out.println(arr2[i]);
    }
    public static void foo(char[] arr){
        for (int i = 0; i < arr.length; i++)
            arr[i]++;
    }

    Solution:
    b
c
d
(d) (4 points)
    public static void main(String[] args) {
        int[][] mat = {{1, 2, 3}, {5, 6, 7, 8}};
        int[] r = foo(mat);
        System.out.println(r[0]);
        System.out.println(r[1]);
    }
    public static int[] foo(int[][] mat) {
        int[] res = new int[2];
        res[0] = mat.length;
        res[1] = mat[0].length;
        return res;
    }

    Solution:
    2
    3
(e) (2 points)
public static void main (String[] args) {
    int[][] mat = new int[5][];
    for (int i = 0; i < mat.length; i++) {
        System.out.println(foo(mat[i]));
    }
}

public static int foo(int[] arr) {
    return arr.length;
}

Solution:
error. NullPointerException. mat[i] is not initialized.

(f) (4 points)
public static void main(String[] args) {
    int[] arr = { 1, 3, 5 };
    foo(arr);
    for (int i = 0; i < arr.length; i++) {
        System.out.println(arr[i]);
    }
}

public static void foo(int[] arr) {
    int[] r = { 2, 4, 6 };
    arr = r;
}

Solution:
1
3
5
2. (20 points) Read the following Java program and write the output in each location. You may write “error” if the statement has syntax errors.

```java
public class T {
    public static int x = 10;
    public static int y = 10;
    public static void foo (int x) {
        int y = 10;
        x += y;
        T.x += y;
        System.out.println(x); // Location 1
        System.out.println(y); // Location 2
        System.out.println(z); // Location 3
    }
    public static void bar (int y) {
        int z = 10;
        x += z;
        T.y += y;
        System.out.println(x); // Location 4
        System.out.println(y); // Location 5
        System.out.println(z); // Location 6
    }
    public static void main (String[] args) {
        int x = 10;
        {
            int y = 20;
            x += y;
            foo(x);
            bar(y);
        }
        System.out.println(x); // Location 7
        System.out.println(y); // Location 8
        System.out.println(T.x); // Location 9
        System.out.println(T.y); // Location 10
    }
}
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1</td>
<td>40</td>
</tr>
<tr>
<td>Location 2</td>
<td>10</td>
</tr>
<tr>
<td>Location 3</td>
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<td>Location 9</td>
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<tr>
<td>Location 10</td>
<td>30</td>
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</tbody>
</table>
3. Read the following Java program and answer the question below.

```java
public static int foo(int[] arr) {
    int c = arr[0], r = 1, k = 1;
    for (int i = 1; i < arr.length(); i++) {
        if (k != i)
            arr[k] = arr[i];
        if (arr[i] == c) {
            if (++r <= 2)
                k++;
        } else {
            c = arr[i];
            k++;
            r = 1;
        }
    }
    return k;
}
public static void main(String[] args) {
    int arr1 = { 1, 2, 2, 3, 3, 3 };  
    int n = foo(arr1);
    for (int i = 0; i < n; i++) {
        System.out.print(arr1[i] + " ");
    }
}
```

(a) (4 points) Find syntax errors in the above code and fix them.

**Solution:**
No. 1) In line 3, change `arr.length()` to `arr.length();` 2) In line 18, change `int` to `int[]`.

(b) (4 points) What’s the output?

**Solution:**
1 2 2 3 3

(c) (4 points) Can you modify only ONE line in the `foo` method to make the output be 1 2 3 ?

**Solution:**
Change line 7 to
if (++r <= 1)
4. (20 points) Write a method called `diagSum` which takes a two dimensional integer array (a matrix), `mat`, as argument and returns the sum of the diagonal elements of `mat`. For example, if

\[
\begin{pmatrix}
1 & 2 & 3 & 4 \\
5 & 6 & 7 & 8 \\
9 & 10 & 11 & 12 \\
13 & 14 & 15 & 16
\end{pmatrix}
\]

this method should return 68 (diagonal elements are highlighted). You may assume `mat` has same number of rows and columns.

Solution:

```java
public static int diagSum(int[][] mat){
    int sum = 0;
    int n = mat.length;
    for (int i=0;i<n;i++) {
        sum += mat[i][i] + mat[i][n-1-i];
    }
    if (n % 2 == 1) {
        sum -= mat[n/2][n/2];
    }
    return sum;
}
```
5. Write two methods both called \textit{isSorted}, but have different functionalities.

(a) (12 points) This method takes an integer array, \textit{arr}, as argument and returns true if \textit{arr} is already sorted in ascending order, otherwise returns false. You \textbf{MAY NOT} use any method from the \textit{Arrays} class.

\begin{verbatim}
SOLUTION:
public static boolean isSorted(int[] arr) {
    for (int i = 1; i < arr.length - 1; i++){
        if (arr[i + 1] < arr[i])
            return false;
    }
    return true;
}
\end{verbatim}
(b) (16 points) This method takes a two dimensional integer array (a matrix), mat, as argument and returns true if both the rows and columns of mat are already sorted in ascending order, otherwise returns false. For example, the matrix
\[
\begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\
\end{bmatrix}
\]
is sorted, since all rows and columns are sorted. However
\[
\begin{bmatrix}
1 & 2 & 3 \\
2 & 5 & 6 \\
3 & 4 & 9 \\
\end{bmatrix}
\]
is not, since the second column (highlighted) is not sorted. You MAY NOT use any method from the Arrays class. Hint: You may invoke the method in Part (a).

**Solution:**
```java
public static boolean isSorted(int[][] mat) {
    for (int i = 0; i < mat.length; i++) {
        if (!isSorted(mat[i]))
            return false;
    }
    for (int i = 0; i < mat[0].length; i++) {
        int[] column = new int[mat.length];
        for (int j = 0; j < mat.length; j++){
            column[j] = mat[j][i];
        }
        if (!isSorted(column))
            return false;
    }
    return true;
}
```
## ASCII TABLE

<table>
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<th>Hex</th>
<th>Char</th>
<th>Decimal</th>
<th>Hex</th>
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