Section, Name and ID#:

AMERICAN UNIVERSITY OF ARMENIA
College of Science and Engineering
CS 120 Introduction to Object-Oriented Programming
MIDTERM EXAM

Date / Time: Friday, March 17 2017 at 17:30
Duration: 2 hours
Attention: **ANY TYPE OF COMMUNICATION IS STRICTLY PROHIBITED**
Write down your section, name and ID# at the top of all used pages

Participation:

Problem 1: Consider below a C++ function ***float kahan(float num1, float num2, float& compensation)*** that implements the ***Kahan Summation Algorithm*** for high-precision compensated summation of two float arguments ***float num1*** and ***float num2***:

```
float kahan(float num1, float num2, float &compensation)
{
    float result;
    num2 -= compensation;
    result = num1 + num2;
    compensation = (result - num1) - num2;
    return result;
}
```

Using this function, write a C++ function ***float pi(int n)*** that computes the value π by the following formula:

$$\pi = 2\sum_{k=0}^{n}\frac{(2k-1)!!}{(2k)!!(2k+1)} = \frac{2}{1*1}+\frac{1}{2}*\frac{2}{3}+\frac{1*3}{2*4}*\frac{2}{5}+\frac{1*3*5}{2*4*6}*\frac{2}{7}+\cdots$$

Recall that **n!!** is the product of odd numbers from *1* to ***n***, if ***n*** is odd; and is the product of even numbers from *2* to ***n***, if ***n*** is even. The double factorial of non-positive numbers equals to *1* by definition.

The initial value of ***float compensation*** is ***0.0***.

```
float pi(int n) {
float sum = 0;
int u;
int d;
  for(int k = 1; k<n; k++) {
    if(k % 2 == 0){
      for(int i = 2; i<=2k-1; i = i + 2){
        u = u*i
    }
    else {
      for(int i=1;i<=2k-1; i = i+2) {
        u = u+i
```

Use the backside, if needed

OOP.MT.170317.L038

```
        for(int i=1; i<=2k-1; i=i+2){
            d=d*i;
        }
        } else {
            for(int i=1; i<=2k; i=i+2){
                d=d+i;
        }
    }
    sum=sum+u/(d*(2k+1))
    }
    return 2*sum;
}
```

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Problem 2: Write a Java method ***public static double[] lin(double[] data)*** that takes as its argument an array of data points ***double[] data***, and returns a two-element array – the first element being the slope of the linear regression and the second element being the intercept. The linear regression approximates the data points by the linear formula

$$y = k\,x + b,$$

where the slope k and the intercept b are computed as

$$k = \frac{\overline{xy} - \bar{x}\,\bar{y}}{\overline{x^2} - \bar{x}^2}, b = \bar{y} - k\,\bar{x}$$

Here $\bar{x}$ is the mean of the x coordinates, $\bar{y}$ is the mean of the y coordinates, $\overline{x^2}$ is the mean of the squares of the x coordinates, and $\overline{xy}$ is the mean of the products of the x and y coordinates. Use the element indices of the array ***double[] data*** as x coordinates and the element values as y coordinates. You may assume and use the method double ***mean(double[] a)***.

```
public static double[] lin(double[]){
    double[] data;
    int[2] arr;
    int k;
    int b;
    int M, m, M1, m1, m2
    int x, y;
    for(int i=0; i < data.length; i++){
        x = i;
        y = data[i]
        M += x;
        m += y;
        M1 += x*y
        m1 += x^2;
    }
    double
    int K = (M1/data.length - M/data.length * m/data.length)
            / (m1/data.length - (M/data.length)^2)
```

Use the backside, if needed

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int b = M%(data.length) - K*M/(data.length)

arr[1] = K;

arr[2] = b;

return? 3

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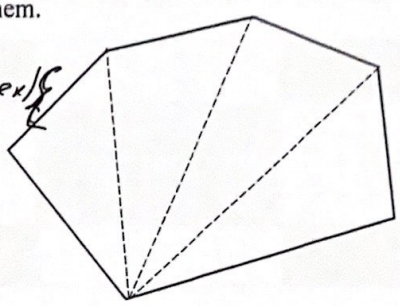
Problem 3: Write a Java function ***public static double area(double[][] vertex)*** that takes as its argument a ***2-by-n*** array of a convex polygon's vertex coordinates ***double[][] vertex*** – the ***x*** coordinates in the first row and ***y*** coordinates in the second row. It returns polygon's area as follows:

1. Divides the polygon into triangles by connecting the ***first*** vertex with the n^{th} and $(n+1)^{st}$ vertices;
2. Adds the areas of the constructed triangles using the formula $area = \sqrt{p(p-a)(p-b)(p-c)}$, where ***a***, ***b*** and ***c*** are the sides and $p = (a+b+c)/2$.

You may assume and use a method ***double dist(double x1, double y1, double x2, double y2)*** that takes as its arguments coordinates of two points and returns the distance between them.



```
public static double area(double [][] vertex){
double side = 0;
double p = 0;
double area = 0;
  for(int i=1; i<vertex.length()-1; i++){
    a = dist(vertex[0][0], vertex[0][1], vertex[i][0], vertex[i][1])
    b = dist(vertex[0][0], vertex[0][1], vertex[i+1][0], vertex[i+1][1])
    c = dist(vertex[i][0], vertex[i][1], vertex[i+1][0], vertex[i+1][1])
    p = (a+b+c) // 2;
    area = area + sqrt(p*(p-a)(p-b)(p-c));
    }
  }
}
```

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Problem 4: Write a Java method ***public static void magic4N(int[][] square)*** that creates a magic square of a *4N-by-4N* size using the following algorithm:

1. Creates an array of the same size as ***int[][] square*** and fills it forward with successive integers assigning *1* to the top-left element;
2. Creates anther array of the same size as ***int[][] square*** and fills it backward with successive integers assigning *1* to the bottom-right element;
3. Divides the original ***int[][] square*** into 16 blocks of the same size – 4 blocks per row and column. In the on-diagonal (shaded) blocks copies the elements from the first array, and in the off-diagonal blocks copies the elements from second array.

1	2					7	8
9	10					15	16
		19	20	21	22		
		27	28	29	30		
		35	36	37	38		
		43	44	45	46		
49	50					55	56
57	58					63	64

		62	61	60	59		
		54	53	52	51		
48	47					42	41
40	39					34	33
32	31					26	25
24	23					18	17
		14	13	12	11		
		6	5	4	3		

```
public static void magic4N(int[][] square) {
    int[][] arrForward = new int[square.length()][square.width()];
    int[][] arrBackward = new int[square.length()][square.width()];
    int count = 1;
    for (int i = 0; i < arr.length; i++) {
        for (int j = 0; j < arr.length; j++) {
            arrForward[i][j] = count;
            arrBackward[arr.length-1-i][arr.length-1-j] = count;
            count Change?
        }
    }
}
```


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```
int start=0;
while(start<arr.length(i)){
   for(int i=start; i<2; i++){
      for(int j=start; j<2; j++){
        arr[i][j] = arrForward[i][j];
   }
   }
   start = start+2;
}
}
```

for arbitrary N size?

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