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

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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***.

```
int n;
cin << n;
float pi(int n) {
float result; float[] element;
for (k=0; k<=n; k++) {
if(k%2==0){
element=2*
element[]=(2*(d_fact(2k-1))/
(d_fact(2k)*(2k+1))
result = kahan(element, 0.0)
```

```
int d_fact(int l)
while(l>0; l=l-2){
if(l%2==0){
result*=l }
else{
return result;
```

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Use the backside, if needed

Problem 1 of 4

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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 [] data) {
double k, b; x, y; xy_mean, x_sqr;
for (i=0; i<= data.length; i++) {
x+= i; y+= data[i];
xy_mean+= xy; mean(i* data[i])/ data length; x_sqr i*i;
k = (xy_mean - (x/data length)*(y/data length))/
    ( x_sqr/data length - ((x/data length)*(x/data length));
b = y/data length - k * (x/data length);
}
double [] result = [k, b];
return result;
}
```

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x= 1 2 3
y= 5 6 7

1·5 + 2·6 + 3·7

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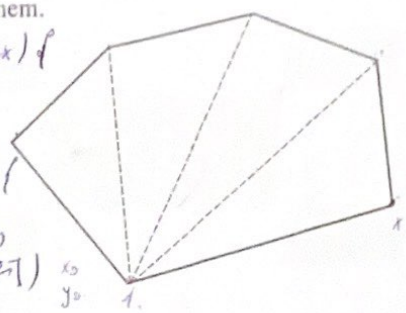
Problem 3: Write a Java function ***public static double area(double[][] vertex)*** that takes as its argument a ***2-by-n*** array of a convex polygon's vertex coordinates ***double[][] vertex*** – the *x* coordinates in the first row and *y* coordinates in the second row. It returns polygon's area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

1. Divides the polygon into triangles by connecting the ***first*** vertex with the k^{th} and $(k+1)^{st}$ 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) {
  for(row=0; row<2; row++) {
    for (col=0; col<vertex[row].length; col++) {
      dist1 = dist(vertex[0][col], vertex[1][col],
        vertex[0][col+1], vertex[1][col+1])
      dist2 = dist(vertex[0][col+1], vertex[1][col+1],
        vertex[0][col+2], vertex[1][col+2])
```

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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

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		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[][] forward, backward = ?

  for(row=0; row < square.length; row++) {
    for(col=0; col < square[row].length; col++) {
      forward[?][?] = col; } }

  for(row = square.length; row >= 0 square.length; row--) {
    for(col = square[row].length; col >= 0; col--) {
      backward[?][?] = col; } }
```

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