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AMERICAN UNIVERSITY OF ARMENIA
College of Science and Engineering
COMP120 Introduction to Object-Oriented Programming
MIDTERM 2 EXAM

Date:	Tuesday, March 24 2015
Starting time:	10:30
Duration:	1 hour 20 minutes
Attention:	**ANY COMMUNICATION IS STRICTLY PROHIBITED**

10/15

Please write down your name at the top of all used pages

Problem 1

The easiest way to implement rotation by 90^0 of a square array is to transpose it and then reverse all its rows separately. Transposing once more after the rotation will result in vertical flip – the top row will appear at the bottom, the second row will become the last but one, etc. Write a C++ function ***void flip(int *a2D, int size)*** that takes as its argument a pointer to the first element of a square array ***int *a2D*** of the specified ***int size*** and flips it vertically. Use already implemented functions ***void reverse(int a1D[], int length)*** and ***void transpose(int *a2D, int size)***:

```
void reverse(int a1D[], int length)
{
      for (int i = 0; i < length / 2; i++)
            swap(a1D[i], a1D[length - 1 - i]);
}

void transpose(int *a2D, int size)
{
      for (int row = 0; row < size; row++)
            for (int col = row + 1; col < size; col++)
                  swap(a2D[row * size + col], a2D[col * size + row]);
}
```

```
void flip (int *a2D, int size)
{
    transpose (a2D, size);
for (int row = 0, row < size, row++)
    reverse (a2D[row], size);
transpose (*a2D, size)
```

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Use the backside, if needed

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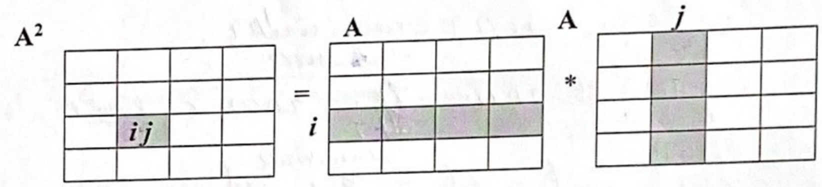
Problem 2

Using functions ***transpose()*** from **Problem 1** and ***scalar()*** from below, write a C++ function ***void square(int *a2D, int *product, int size)*** that takes as its argument a pointer to the first element of a square array ***int *a2D*** of the specified ***int size***, computes its square (multiplies it by itself) and saves it in another square array of the same size, the pointer to the first element of which is given by ***int *product***. Each element p_{ij} in the i^{th} row and j^{th} column of the array ****product*** is the scalar product of the i^{th} row and j^{th} column of the array ****a2D*** and is calculated by the expression: $p_{ij} = \sum_{k=0}^{size-1} a_{ik} a_{kj}$

```
int scalar(int a[], int b[], int length)
{
        int result = 0;
        for (int i = 0; i < length; i++)
                result += a[i] * b[i];
        return result;
}
```



~~int array[100][100] = temp~~

(1)

```
A[size][size];
for ( ~~row~~ i = 0; ~~row~~ i < size; ~~row++~~ i++)
for ( ~~col~~ j = 0; ~~col~~ j < size; ~~col++~~ j++)
  A[~~row~~ i][~~col~~ j] = *(a2D + i*size + j)
void square(int *a2D, int *product, int size)
{ A[size][size];
  for( i=0; i<size; i++)
    for(j=0; j<size; j++)
      A[i][j] = *(a2D + i*size + j);
  transpose(A, size);
  ~~*product~~
  for( ~~col~~ i=0; i<size; i++)
    ~~product[k] = *(product + ...~~
    for( ~~int~~ j=0; j<size; j++)
      product[i][j] = ~~*(product*~~ scalar(a2D[i], A[j], size);
}
```

see Problem 1

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```
void spiral2( int *a2D , int even_size)
{   spiral ( a2D , even_size/2 ) ;
    fdlip ( a2D , even_size/2 ) ;
    reverse(
    for( int i = 0, i < even_size/2 , i++)
       reverse (a2D[i] , even_size/2 ) ;
    a[even_size/2] [even_size/2] ;
    for( int row = even_size/2 ; row < even_size ; row++)
     for( int col = even_size/2 ; col < even_size; col++)
           a[row][col] = a2D[ row % (even_size/2) ]
                                  [col % (even_size/2)] ;
}
```

Nice idea of using spiral() in spiral2()! There are, however 2 mistakes;

1. Algebraic - if quadrant 1 is ready, just rotate entire a2D by 180° and literally repeat for quadrant 4;
2. Fundamental - it is assumed that addresses in quadrant 1 are

0 1 2 ... size/2-1
size/2 ... size-1
...

In reality, they are 0 1 2 ... size/2-1
size size+1 .... size+size/2-1
...

←

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Problem 3

Using, if you wish, ***segment()*** and ***rotate()*** functions from the **C++ Reference Functions** section, write a C++ function ***void spiral2(int *a2D, int even_size)*** that takes as its argument a pointer to the first element of a square array ***int *a2D*** of the specified even size ***int even_size*** and fills its top-left and bottom-right quadrants with spirals of successive values from *1* to ***even_size*** ^{2} / *4* . The remaining two quadrants are filled with zeros. Each spiral propagates horizontally toward the array center, then vertically toward the center, then in opposite directions horizontally and vertically, and so on. Obviously, the spirals do not cross the central axes. A shaded example is shown below:

```
int* segment(int *start, int length, int direction, int increment)
{
      for (; length > 0; length--)
      {
            *(start + direction) = *start + increment;
            start += direction;
      }
      return start;
}
```

1	2	3	0	0	0
8	9	4	0	0	0
7	6	5	0	0	0
0	0	0	5	6	7
0	0	0	4	9	8
0	0	0	3	2	1

~~void spiral2(int *a2D, int even_size)~~

~~{ void rp~~

(1)

```
void spiral(int *center, int odd_size)
int along[4] = {-1, odd_size, 1, -odd_size}, direction = 0
    *center = 1;
for(int l = 1; l < odd_size; l++)
 { for (int s = 0; s < l; s++)
  { *(center + along[direction]) = *center - 1;
  center += along[direction];
  }
 for(int s = 0; s < l; s++)
 { ~~*center = 0; s < l; s++~~
   *(center + along[direction + 1]) = *center - 1;
    center += along[direction + 1];
  }
  direction = 2 - direction;
 }
for(int s = 1; s < odd_size; s++)
{ *(center + along[direction]) = *center - 1;
  center += along[direction];
}
}
```

Use the backside, if needed

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