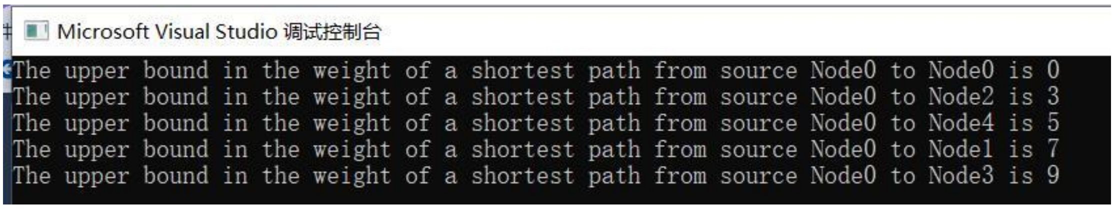
Question1

A: Here is the codes of this problem:

```
#include<iostream>
#include<vector>
#include<limits.h>
#include"Matrix.h"

using namespace std;
using namespace Numeric_lib;

// p is vertex v's self, d is an upper bound in the weight of a shortest path from source s to v
struct vertex
{
    int p;
    int d;
};

void initialize_single_source(vector<vertex>&G)
{
    unsigned int i;
    for (i = 1; i < G.size(); i++)
        G[i].d = INT_MAX;
    G[0].d = 0;
}

vertex extract_min(vector<vertex>&Q)
{
    unsigned int i;
    vertex min;
    int min1=0;
    min = Q[0];
    for (i = 0; i < Q.size(); i++)
    {
        if (Q[i].d <= min.d)
        {
            min = Q[i];
            min1 = i;
        }
    }
    Q.erase(Q.begin() + min1);
    return min;
```

```
}

void relax(vertex &u, vertex &v, Matrix<int, 2>&w)
{
	if (v.d > u.d + w(u.p, v.p))
		v.d = u.d + w(u.p, v.p);
}

void dijkstra(vector<vertex>&G, Matrix<int, 2>&w,vector<vertex>&S)
{
	initialize_single_source(G);
	vector<vertex>Q;
	vertex u;
	Q = G;
	int i;
	unsigned int j;
	while (Q.size()> 0)
	{
		u = extract_min(Q);
		S.push_back(u);
		for (i = 0; i < w.dim1(); i++)
		{
			if (w(u.p, i) != NULL)
			{
				for (j = 0; j < Q.size(); j++)
				{
					if (Q[j].p == i)
						relax(u,Q[j],w);
				}
			}
		}
	}
}

// n is the number of nodes
int main()
{
	int n=5;
	unsigned int i;
	vector<vertex>G(n);
	vector<vertex>S;
	Matrix<int, 2>w(n, n);
	for (i = 0; i < G.size(); i++)
		G[i].p = i;
	w(0, 1) = 10;
	w(0, 2) = 3;;
	w(1, 2) = 1;
	w(1, 3) = 2;
	w(2, 1) = 4;
	w(2, 3) = 8;
	w(2, 4) = 2;
	w(3, 4) = 9;
	w(4, 3) = 11;
	dijkstra(G, w,S);
	for (i = 0; i < S.size(); i++)
		cout <<"The upper bound in the weight of a shortest path from source Node0 to Node"<< S[i].p << " is " << S[i].d << endl;
}
```

And the result is below:



```
The upper bound in the weight of a shortest path from source Node0 to Node0 is 0
The upper bound in the weight of a shortest path from source Node0 to Node2 is 3
The upper bound in the weight of a shortest path from source Node0 to Node4 is 5
The upper bound in the weight of a shortest path from source Node0 to Node1 is 7
The upper bound in the weight of a shortest path from source Node0 to Node3 is 9
```

Question2

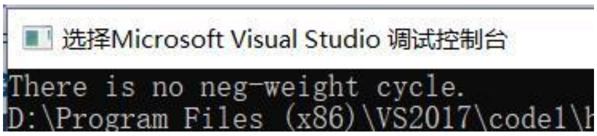
A: Here is the codes of this problem:

```
#include<iostream>
#include<vector>
#include<limits.h>
#include"Matrix.h"

using namespace std;
using namespace Numeric_lib;

// p is vertex v's self, d is an upper bound in the weight of a shortest path from source s to v
struct vertex
{
	int p;
	int d;
};
```

```
void initialize_single_source(vector<vertex>&G)
{
    unsigned int i;
    for (i = 1; i < G.size(); i++)
        G[i].d = INT_MAX;
    G[0].d = 0;
}

void relax(vertex &u, vertex &v, Matrix<int, 2>&w)
{
    if (v.d > u.d + w(u.p, v.p))
        v.d = u.d + w(u.p, v.p);
}

bool bellman_ford(vector<vertex>&G, Matrix<int, 2>&w)
{
    initialize_single_source(G);
    unsigned int i,j,k,m;
    for (i = 0; i < G.size()-1; i++)
    {
        for (j = 0; j < G.size(); j++)
        {
            for (k = 0; k < G.size(); k++)
            {
                if (w(j, k) != NULL)
                {
                    for (m = 0; m < G.size(); m++)
                    {
                        if (G[m].p == k)
                            relax(G[j], G[m], w);
                    }
                }
            }
        }
    }
    for (i = 0; i < G.size(); i++)
    {
        for (j = 0; j < G.size(); j++)
        {
            if (w(i, j) != NULL)
            {
                for (k = 0; k < G.size(); k++)
                {
                    if ((G[k].p == j) && (G[k].d > G[i].d + w(G[i].p, G[k].p)))
```

```
                                return false;
                        }
                }
            }
        }
        return true;
}

int main()
{
        int n = 5;
        unsigned int i;
        vector<vertex>G(n);
        for (i = 0; i < G.size(); i++)
                G[i].p = i;
        Matrix<int, 2>w(n,n);
        bool c;
        w(0, 1) = -1;
        w(0, 2) = 4;
        w(1, 2) = 3;
        w(1, 3) = 2;
        w(1, 4) = 2;
        w(3, 1) = 1;
        w(3, 2) = 5;
        w(4, 3) = -3;
        c = bellman_ford(G, w);
        if (c)
                cout << "There is no neg-weight cycle.";
        else
                cout << "A neg-weight cycle exists.";
}
```

And the result is below:



```
There is no neg-weight cycle.
D:\Program Files (x86)\VS2017\code1\h
```