МИНИСТЕРСТВО ОБРАЗОВАНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ

ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

Факультет прикладной математики и информатики

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Вариант 11

(“Методы вычислений”)

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Преподаватель

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Исходный код

```
#include <iostream>
#include <vector>
#include <ctime>
using namespace std;

int main()
{


    setlocale(LC_ALL, "rus");

    int n = 0;
    cout << "n: " << endl;
    cin >> n;

    long double** A = new long double* [n];
    long double** L = new long double* [n];
    long double** U = new long double* [n];
    long double** D = new long double* [n];
    long double** G = new long double* [n];
    long double** E = new long double* [n];
    long double** NG = new long double* [n];
    long double* b = new long double[n];
    long double* x = new long double[n];
    long double* y = new long double[n];

    for (int i = 0; i < n; i++)
    {
        A[i] = new long double[n];
        L[i] = new long double[n];
        U[i] = new long double[n];
        D[i] = new long double[n];
        G[i] = new long double[n];
        NG[i] = new long double[n];
        E[i] = new long double[n];
        b[i] = 0;
        x[i] = 0;
        y[i] = 0;
    }


    cout << endl << "A: " << endl;
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            cin >> A[i][j];
            L[i][j] = 0;
            D[i][j] = 0;
            G[i][j] = 0;
            NG[i][j] = 0;
            E[i][j] = 0;
        }
        L[i][i] = 1;
```

```
    }
    cout << endl << "b: " << endl;
    for (int i = 0; i < n; i++)
    {
        cin >> b[i];
    }

    U = A;
    srand(time(0));
```

```
auto start = chrono::system_clock::now();
```

```
for (int i = 0; i < n - 1; i++)
{
    for (int j = i+1; j < n; j++)
    {
        if (U[i][i] != 0)
        {
            L[j][i] = U[j][i] / U[i][i];
        }
        for (int g = i; g < n; g++)
        {
            U[j][g] -= L[j][i] * U[i][g];
        }
    }
}
```

```
for (int i = 0; i < n; i++)
{
    D[i][i] = sqrt(abs(U[i][i]));
    if (U[i][i] != 0)
    {
        E[i][i] = U[i][i] / abs(U[i][i]);
    }
}
for (int i = 0; i < n; i++)
{
    for (int j = 0; j < n; j++)
    {
        for (int k = 0; k < n; k++)
        {
            G[i][j] += L[i][k]*D[k][j];
        }
    }
}

for (int i = 0; i < n; i++)
{
    for (int j = 0; j < n; j++)
    {
        for (int k = 0; k < n; k++)
        {
            NG[i][j] += G[i][k] * E[k][j];
        }
    }
}
long double ll = 0;
for (int i = 0; i < n; i++)
{
    if (NG[i][i] == 0)
    {
```

```
            y[i] = 0;
        }
        else {
            ll = b[i];
            for (int j = 0; j < n; j++)
            {
                ll -= NG[i][j]*y[j];
            }
            y[i] = ll / NG[i][i];
        }
    }
    for (int i = n - 1; i >= 0; i--)
    {
        if (G[i][i] == 0)
        {
            x[i] = 0;
        }
        else {
            ll = y[i];
            for (int j = 0; j < n; j++)
            {
                ll -= G[j][i]*x[j];
            }
            x[i] = ll / G[i][i];
        }
    }
```

```
auto end = chrono::system_clock::now();
chrono::duration<double> elapsed_seconds = end - start;
cout <<endl <<"time: " << elapsed_seconds.count() << "s\n";
```

```
    for (int i = 0; i < n; i++)
    {
        cout << x[i] << " ";
    }
    cout << endl;
    cout << endl;
    cout << "G: " << endl;
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            cout << G[i][j] << " ";
        }
        cout << endl;
    }
    cout << endl;
    cout << "H: " << endl;
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            cout << D[i][j] << " ";
        }
        cout << endl;
    }
    cout << endl;
```

```
    cout << "L: " << endl;
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            cout << L[i][j] << " ";
        }
        cout << endl;
    }
    cout << endl;
    cout << "U: " << endl;
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            cout << U[i][j] << " ";
        }
        cout << endl;
    }

}
```

Задание 1

1)

```
n:
 3

A:


9 0 6
0 -4 10
6 10 -20

b:


3 -10 26

time = 2.623

x:
1 0 -1

G:
3 0 0
0 2 0
2 -5 1

H:
3 0 0
0 2 0
0 0 1

L:
1 0 0
0 1 0
0.666667 -2.5 1

U:
9 0 6
0 -4 10
0 0 1
```

2)

```
n:
10

A:
25 0 10 20 5 -20 20 25 5 20
0 -16 -8 -8 12 -20 12 -4 0 0
10 -8 36 -2 20 -12 8 8 8 26
20 -8 -2 49 -10 3 17 6 -15 43
5 12 20 -10 -20 13 11 9 22 10
-20 -20 -12 3 13 -17 -36 -22 -14 -22
20 12 8 17 11 -36 -52 6 -10 -27
25 -4 8 6 9 -22 6 -6 -2 10
5 0 8 -15 22 -14 -10 -2 -26 -3
20 0 26 43 10 -22 -27 10 -3 -38

b:
625
-96
574
624
474
-895
-701
54
-355
-328

time = 40.694

x:
1 2 3 4 5 6 7 8 9 10

G:
5 0 0 0 0 0 0 0 0 0
0 4 0 0 0 0 0 0 0 0
2 2 6 0 0 0 0 0 0 0
4 2 -1 6 0 0 0 0 0 0
1 -3 2 -3 5 0 0 0 0 0
-4 5 1 5 -3 5 0 0 0 0
4 -3 -1 -1 -3 4 6 0 0 0
5 1 0 -2 1 -2 5 2 0 0
1 0 1 -3 -2 -2 3 -2 4 0
4 0 3 5 -3 5 1 4 1 6

H:
5 0 0 0 0 0 0 0 0 0
0 4 0 0 0 0 0 0 0 0
0 0 6 0 0 0 0 0 0 0
0 0 0 6 0 0 0 0 0 0
0 0 0 0 5 0 0 0 0 0
0 0 0 0 0 5 0 0 0 0
0 0 0 0 0 0 6 0 0 0
0 0 0 0 0 0 0 2 0 0
0 0 0 0 0 0 0 0 4 0
0 0 0 0 0 0 0 0 0 6

L:
1 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0
0.4 0.5 1 0 0 0 0 0 0 0
0.8 0.5 -0.166667 1 0 0 0 0 0 0
0.2 -0.75 0.333333 -0.5 1 0 0 0 0 0
-0.8 1.25 0.166667 0.833333 -0.6 1 0 0 0 0
0.8 -0.75 -0.166667 -0.166667 -0.6 0.8 1 0 0 0
1 0.25 0 -0.333333 0.2 -0.4 0.833333 1 0 0
0.2 -0 0.166667 -0.5 -0.4 -0.4 0.5 -1 1 0
0.8 -0 0.5 0.833333 -0.6 1 0.166667 2 0.25 1

U:
25 0 10 20 5 -20 20 25 5 20
0 -16 -8 -8 12 -20 12 -4 0 0
0 0 36 -6 12 6 -6 0 6 18
0 0 0 36 -18 30 -6 -12 -18 30
0 0 0 0 -25 15 15 -5 10 15
0 0 0 0 0 -25 -20 10 10 -25
0 0 0 0 0 0 -36 -30 -18 -6
0 0 0 0 0 0 0 -4 4 -8
0 0 0 0 0 0 0 0 -16 -4
0 0 0 0 0 0 0 0 0 -36
```

3)

```
n:
10

A:
100 -4950 79200 -600600 2522520 -6306300 9609600 -8751600 4375800 -923780 -4950 326700
 -5880600 47567520 -208107900 535134600 -832431600 770140800 -389883780 83140200 79200
-5880600 112907520 -951350400 4281076800 -11237826600 17758540800 -16635041280 8506555200
-1829084400 -600600 47567520 -951350400 8245036800 -37875637800 101001700800
-161602721280 152907955200 -78843164400 17071454400 2522520 -208107900 4281076800
-37875637800 176752976400 -477233036280 771285715200 -735869534400 382086104400
-83223340200 -6306300 535134600 -11237826600 101001700800 -477233036280 1301544644400
-2121035716800 2037792556800 -1064382719400 233025352560 9609600 -832431600 17758540800
-161602721280 771285715200 -2121035716800 3480673996800 -3363975014400 1766086882560
-388375587600 -8751600 770140800 -16635041280 152907955200 -735869534400 2037792556800
-3363975014400 3267861442560 -1723286307600 380449555200 4375800 -389883780 8506555200
-78843164400 382086104400 -1064382719400 1766086882560 -1723286307600 912328045200
-202113826200 -923780 83140200 -1829084400 17071454400 -83223340200 233025352560
-388375587600 380449555200 -202113826200 44914183600

b:
-19930830 1825120440 -40513825440 379810431000 -1855066433220 5196243812760 -8656214046480 8471034205920 -4494352236660
997272241680

time = 17.771

x:
4.00016 -0.999861 -0.999875 5.00011 5.0001 -4.99991 -3.99991 4.00008 2.00008 -3.99993

G:
10 0 0 0 0 0 0 0 0 0
-495 285.788 0 0 0 0 0 0 0 0
7920 -6858.92 1770.97 0 0 0 0 0 0 0
-60060 62416.2 -26859.6 4540.11 0 0 0 0 0 0
252252 -291276 161158 -47671.1 6006 0 0 0 0 0
-630630 780202 -503618 198630 -45045 4527.19 0 0 0 0
960960 -1.24832e+06 895322 -423744 131040 -24145 2019.11 0 0 0
-875160 1.17897e+06 -913228 491157 -185640 47361.4 -7355.32 526.726 0 0
437580 -606329 498124 -294694 128520 -40595.5 8826.39 -1185.13 74.2159 0
-92378 130912 -112671 71784.5 -34884 12855.2 -3493.78 662.28 -78.339 4.35892

H:
10 0 0 0 0 0 0 0 0 0
0 285.788 0 0 0 0 0 0 0 0
0 0 1770.97 0 0 0 0 0 0 0
0 0 0 4540.11 0 0 0 0 0 0
0 0 0 0 6006 0 0 0 0 0
0 0 0 0 0 4527.19 0 0 0 0
0 0 0 0 0 0 2019.11 0 0 0
0 0 0 0 0 0 0 526.726 0 0
0 0 0 0 0 0 0 0 74.2159 0
0 0 0 0 0 0 0 0 0 4.35892

L:
1 0 0 0 0 0 0 0 0 0
-49.5 1 0 0 0 0 0 0 0 0
792 -24 1 0 0 0 0 0 0 0
-6006 218.4 -15.1667 1 0 0 0 0 0 0
25225.2 -1019.2 91 -10.5 1 0 0 0 0 0
-63063 2730 -284.375 43.75 -7.5 1 0 0 0 0
96096 -4368 505.556 -93.3333 21.8182 -5.33333 1 0 0 0
-87516 4125.33 -515.667 108.182 -30.9091 10.4615 -3.64286 1 0 0
43758 -2121.6 281.273 -64.9091 21.3986 -8.96703 4.37143 -2.25 1 0
-9237.8 458.073 -63.6212 15.8112 -5.80819 2.83956 -1.73036 1.25735 -1.05556 1

U:
100 -4950 79200 -600600 2.52252e+06 -6.3063e+06 9.6096e+06 -8.7516e+06 4.3758e+06 -923780
0 81675 -1.9602e+06 1.78378e+07 -8.32432e+07 2.22973e+08 -3.56756e+08 3.36937e+08 -1.73282e+08 3.74131e+07
0 0 3.13632e+06 -4.75675e+07 2.85405e+08 -8.91891e+08 1.58558e+09 -1.6173e+09 8.82161e+08 -1.99536e+08
0 0 0 2.06126e+07 -2.16432e+08 9.01801e+08 -1.92384e+09 2.22991e+09 -1.33794e+09 3.2591e+08
0 0 0 0 3.6072e+07 -2.7054e+08 7.87026e+08 -1.11495e+09 7.71891e+08 -2.09513e+08
0 0 0 0 0 2.04955e+07 -1.09309e+08 2.14414e+08 -1.83784e+08 5.81981e+07
0 0 0 0 0 0 4.0768e+06 -1.48512e+07 1.78214e+07 -7.05432e+06
0 0 0 0 0 0 0 277440 -624240 348840
0 0 1.19209e-07 0 0 0 0 0 5508 -5814
-1.16415e-10 0 0 0 0 0 0 0 -9.09495e-13 19.0002
```

Задание 2

Задача называется плохо обусловленной если число обусловленности велико, как и в нашем примере.

При изменении одного значения вектора b результаты сильно отличается.

```
b:
-19930830 1825120440 -40513825440 379810431000 -1855066433220 5196243812760 -8656214046480 8471034205920 -4494352236660
997272241680

time = 93.471

x:
4.00016 -0.999861 -0.999875 5.00011 5.0001 -4.99991 -3.99991 4.00008 2.00008 -3.99993
```

```
b:
-19930830 1825120440 -40513825440 379810431000 -1855066433221 5196243812760 -8656214046480 8471034205920 -4494352236660
997272241680

time = 31.636

x:
3.80016 -1.16653 -1.14273 4.87511 4.88899 -5.0999 -4.09082 3.91675 1.92315 -4.07136
```

```
b:
-19930830 1825120440 -40513825440 379810431000 -1855066433222 5196243812760 -8656214046480 8471034205920 -4494352236660
997272241680

time = 28.571

x:
3.60016 -1.33319 -1.28558 4.75012 4.77789 -5.1999 -4.18173 3.83342 1.84623 -4.14278
```

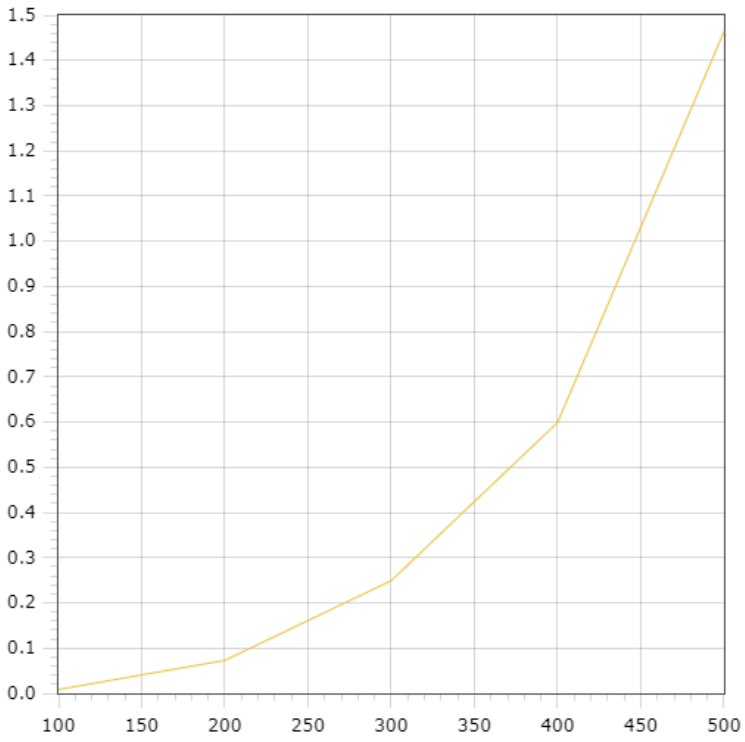
```
b:
-19930830 1825120440 -40513825440 379810431000 -1855066433210 5196243812760 -8656214046480 8471034205920 -4494352236660
997272241680

time = 34.068

x:
6.00013 0.666786 0.428679 6.2501 6.1112 -3.99992 -3.09083 4.8334 2.7693 -3.28565
```

Задание 3

Время



размер

Координаты

x; y;

100.0; 0.00849

200.0; 0.0729179

300; 0.249237

400; 0.599332

500; 1.46409

За минуту примерно работает для матрицы 1400 на 1400