O'ZBEKSTAN BAYLANIS HA'M
INFORMATSIYALASTIRIW AGENTLIGI
TASHKENT INFORMATSIYA TEXNOLOGIYALARI
UNIVERSITETI
NO'KIS FILIALI
INFORMATSIYA TEXNOLOGIYALARI FAKU'LTETI
INFORMATIKA HA'M INFORMATSIYA
TEXNOLOGIYALARI PA'NINEN

KURS JUMISI

TEMA: Turbo Paskal tilinde ten'lemeler sistemasin sheshiwge programmalar du'ziw.

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No'kis-2012

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PASCAL TILI HAQQINDA TU'SINIK

Pascal tili ilmiy texnikaliq, programmistlik ma'selelerdi sheshiwde ken' ko'lemde paydalanatug'in algoritmlik til. Usi algoritmlik til Shveysariyaliq professor Virt Niklaus ta'repinen 1971-jilda jaratilg'an. Pascal algoritmlik tili ja'mlewshi mashinani jaratqan Frantsuz fizigi Blez Pascal eslewine qoyilg'an.

Pascal tilinin' alfavitine to'mendegiler kiredi:

1. A dan Z g'a shekem bolg'an 26 ta latin alipbesi ha'ripleri.

2. Arab tsifrlari: 1,2,3,4,5,6,7,8,9,0.

3. Arifmetikaliq a'meller. Pascal tilinde to'mendegi arifmetikaliq a'meller bar: ko'beytiriw(*), ma'selen: A*V; bo'liw(/), ma'selen: A/V; qosiw(+), ma'selen: A+V; ayiriw(-), ma'selen:

A-V; Pascal tilinde da'rejege ko'teriw a'meli isletilmeydi. Sonin' ushin ha'm sanlardi pu'tin da'rejege ko'teriwde (da'reje ko'rsetkishi u'lken san bolmasa)olardi bir neshe ma'rtebe ko'beytiriw joli menen a'melge asiriw mu'mkin. Haqiyqiy da'rejege ko'teriw (eger tiykar on' san bolsa) logarifmlew joli menen a'melge asiriladi:

4. Mu'nasebet a'mel belgilari: < (kishi), <=(kishi yaki ten'), >(u'lken), >= (u'lken yaki ten'), = (ten'), <> (ten' emes);

5. Arnawli belgiler: . (noqat) , (u'tir) ; (noqatli u'tir) : (eki noqat), apiwayi, kvadrat ha'm figurali qawislar: ( ), [ ] , { } ha'm tag'i basqa. At. At yamasa identifekatorlar o'zgeriwshilerdi, o'zgermeslerdi, tu'rlerdi, proseduralardi ha'm funktsiyalardi at qoyiw ushin isletiledi. At ha'rip ha'm tsifrlardan ibarat bolip, barqulla ha'ripten baslaniwi kerek. Ma'selen: X2, AB2, Y2, Z3, ALFA, BETTA. San. Sanlar pu'tin ha'm haqiyqiy boliwi mu'mkin. Pu'tin sanlar o'nli tsifrlar ja'rdeminde belgili yamasa belgisiz ko'riniste jaziladi:

Ma'selen: 5; -55; 73; - 72867; 5205300. haqiyqiy sanlar qo'zg'almas ha'm qozg'aliwshi noqatli ko'rinislerde jaziladi:

Ma'selen: 0.65; -5E-02; 150.8; 1.7E2; -86.79.

Qatarlar. Pascal tilinde qatarlar apostrof ishine aling'an belgiler izbe-izliginen ibarat boladi. Ma'selen: 'array', 'informatika', 'matematika' siyaqlilar.

O'zgermesler. Pascal algoritmlik tilinde o'zgermesler: pu'tin(integer), haqiqiy(real), logikaliq (boolean), belgili(char), tekstli(text) ko'rinislerinde boliwi mu'mkin. Pu'tin yamasa haqiqiy tu'rdegi o'zgermesler, aldina + yamasa - belgisi qoyilg'an tsifrlardan payda boladi.

Logikaliq tiptegi o'zgermesler tek g'ana 2 logikaliq ma'nis true (ras) ha'm false (jalg'an) ma'nislerin qabil qiliwi mu'mkin.

Belgili tipke tiyisli bolg'an o'zgermesler qostirnaq belgisi ishine aling'an belgilar ko'rinisinde jaziladi. Ma'selen: "Kassa", "Informatika". Tekstli konstantalar (qatarlar) belgiler izbe-izligin qostirnaq belgisi ishine alip jaziladi. Ma'selen: "Y=", "Koren=", "qosindi=" ha'm basqa.

O'zgeriwshiler. Usi algoritmlik tilde programmada qatnasip atirg'an o'zgeriwshi ko'lemlerdi belgilep jaziw ushin o'zgeriwshilerden paydalaniladi. Pascal tilinde apiwayi ha'm indeksli o'zgeriwshilerden paydalaniladi. Apiwayi o'zgeriwshiler pu'tin, haqiqiy, logikaliq ha'm belgili tiplerdin' birewine tiyisli boliwi mu'mkin.

Ma'selen: SR, XMAX, DELTA, IFA, REZ, SUMAR.

Indeksli o'zgeriwshiler massivlerdin' elementin payda qiladi. Uliwma atqa iye bolg'an o'zgeriwshiler toplamin massivler dep ataw mu'mkin. Bir indeks menen belgilengen massivler bir o'lshewli massiv dep, eki indeks penen belgilengen massivler bolsa eki o'lshewli massiv dep ataladi. Massivlerdin' elementleri kvadrat(o'rta)[ ] qawisga alinip jaziladi.

Ma'selen: A[4], A[I] - bir o'lshewli massivler, V[2,5], B(I,J] - eki o'lshewli massivler.

Standart funktsiyalar. Programmada tez-tez ushrap turatug'in funktsiyalardin' ma'nislerin esaplawdi jen'illestiriw maqsetinde standart funksiyalardan paydalaniladi. Standart funksiyalardi jaziwda daslep olardin' atlari onnan keyin bolsa kishi qawisqa alinip argumentlerin jaziw kerek.

Funksiya ati Matematikada jaziliwi Pascal tilinde jaziliwi:

Absolyut ma'nisi	ABS(X)
Kvadrat koren	SQRT(X)

Sinus	sinx	SIN(X)
Kosinus	cosx	COS(X)
Tangens	tgx	TAN(X)
Eksponenta	ex	EXP(X)
Natural logarifm		LN(X)
Arktangens	arctgx	ARCTAN(X)
Kvadratqa ko'teriw	x2	SQR(X)
X tin' putin bo'limi		TRUNC(X)
Yaxlitlash		ROUND(X)
Alding'i ma'nis		PRED(X)
Na'wbettegi ma'nis		SUCC(X)
Jupliqti tekseriw		ODD(X)

Qalg'an keri trigonometriyaliq funksiyalar matematikadag'i bar to'mendegi formulalar arqali arktanges funktsiya jardeminde aniqlanadi.

Programma strukturasi. Pascal algoritmlik tilinde programma onin' sarlavhasi ha'm blok dep ataliwshi tanasidan ibarat. Programma sarlavhasi, programmanin' har dayim birinshi qatarina jaziladi ha'm Program xizmetshi so'zi menen baslanadi. Program so'zinen keyin programma ati ha'm apiwayi qawis ishine programmanin' islewi ushin baylanisli parametrlar input(kiritiw) ha'm output(shig'ariw) fayllari jaziladi. Ma'selen: Program summa(input, output);

Programma sarlavhasi; (noqat u'tir) menen tamamlanadi. Programmanin' denesi eki tiykarg'i bo'limnen ibarat: tasfirlew ha'm operatorlar bo'limi.

Tasfirlew bo'limi to'mendegi bo'limlerden ibarat:

a). nishanlar (metkalar)di aniqlaw;

b). konstantalardi aniqlaw;

v). o'zgeriwshilerdi aniqlaw;

g). tu'rlerdi aniqlaw.

Har bir tasfirlew ha'm aniqlaw noqat u'tir menen tamamlanadi.

Metkalardi aniqlaw bo'limi Label xizmetshi so'zi menen baslanadi ha'm Label dan keyin programmada isletilgen metkalar u'tir menen ajratilgan halda jaziladi. Ma'selen: Label 5, 65, 100; Metkalar sipatinda on' pu'tin (natural) sanlar isletiledi. Metka operatordan eki noqat (:) penen ajratiladi. Eger programmada metka isletilmese, ol jag'dayda metkani aniqlaw bo'limi jazilmaydi. O'zgermeslerdi aniqlaw bo'limi Const xizmetshi so'zi menen baslanadi ha'm bunnan keyin programmada isletilip atirg'an o'zgermesler ha'm olardin' sanli ma'nisleri jaziladi. O'zgermesler ati ha'm ma'nisi = simvoli menen ajratiladi. Har bir o'zgermesdi aniqlaw ; (noqatli u'tir) simvoli menen tawsiladi. Ma'selen: const A=5,5; B=3,5; P1=3.141593; K=7; L=13; o'zgermeslerdi tasfirlew programmani tu'siniwde ha'm o'zgertiriw kiritiwde qolayliq tuwdiradi. O'zgeriwshilerdi tasfirlew bo'limi Var xizmati so'zi menen baslanadi ha'm onnan keyin programmada qatnasiwshi o'zgeriwshiler ha'm tipleri jaziladi. Uliwma jag'dayda o'zgeriwshilerdi tasfirlew bo'limi to'mendegi ko'riniste boladi: Var v1, v2, v3,...,vn:T; bul jerde v1, v2, v3,...,vn -o'zgeriwshiler; T-o'zgeriwshiler tipi(real, integer, char, boolean).

Ma'selen: Var a,b,c: real;

p,k: integer;

q,s: char;

t,r: boolean;

Turbo Paskal programmalastiriw tilinin' uliwma ko'rinisi.

File Edit Search Run Compile Debug Tools Options Window Help
NONAME00.PAS
1:1
F1 Help F2 Save F3 Open Alt+F9 Compile F9 Make Alt+F10 Local menu

1 - Tajriybe jumisi

Siziqli ten'lemeler sistemasin keri matritsalar usuli menen sheshiw

Usi u'sh belgisiz siziqli ten'lemeler sistemasi berilgen bolsa:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + a_{13}x_3 = b_1, \\ a_{21}x_1 + a_{22}x_2 + a_{23}x_3 = b_2, \\ a_{31}x_1 + a_{32}x_2 + a_{33}x_3 = b_3 \end{cases}$$

oni keri matritsalar usuli jardeminde sheshemiz.

Ten'lemeler sistemasinda qatnasip atirg'an $a_{ij}, b_i (i, j = 1,2,3)$ o'zgermes koeffitsientler to'mendegi tablitsada berilgen.

1-tablitsa

Variant	a_{11}	a_{12}	a_{13}	a_{21}	a_{22}	a_{23}	a_{31}	a_{32}	a_{33}	b_1	b_2	b_3
1	4	-3	1	5	-2	7	1	2	1	-8	9	3
2	1	0	3	2	1	4	-1	1	-2	7	9	-3
3	-2	2	1	4	-5	0	3	7	1	9	-13	4
4	-1	2	4	5	0	8	-7	1	3	16	14	24
5	3	2	1	-4	1	3	-2	0	2	-7	18	10
6	0	-1	3	5	0	4	-1	-3	7	8	22	20
7	1	-1	1	-2	0	-5	2	1	3	6	13	4
8	-1	1	3	-4	0	3	-2	1	4	12	17	17
9	1	1	-2	1	3	0	5	-1	2	-7	20	-5
10	2	-1	0	3	1	4	-5	4	-3	-5	7	5

U'lgili misal ha'm ko'rsetpeler

$$\begin{cases} 3x_1 - 2x_2 + 4x_3 = 4, \\ 2x_1 + 4x_2 - 5x_3 = -15, \\ -7x_1 + x_2 - 8x_3 = -9, \end{cases}$$

algebraliq ten'lemeler sistemasi keri matritsalar usullari jardeminde sheshemiz.

Berilgan ten'lemeler sistemasin $A \cdot X = B$ ko'riniste jazib alamiz. Bul jerde

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}, \quad B = \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix}, \quad X = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

Eger A matritsanin' determinanti $\Delta \neq 0$ bolsa, ol jag'dayda $A \cdot A^{-1} = E$ ten'likti qanaatlantiriwshi A^{-1} matritsa A matritsag'a keri matritsa deyiledi. Bul jerde E-birlik matritsa, yag'niy

$$E = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Eger A matritsag'a keri bolg'an A^{-1} matritsa payda bolsa, ol jag'dayda berilgen sistemanin' sheshimi

$$X = A^{-1} \cdot B$$

formula jardeminde aniqlanadi. A^{-1} matritsani aniqlaw jarayoni to'mendegi algoritmge iye:

1) Berilgen A matritsanin' determinanti esaplanadi

$$\Delta = \det A = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} \neq 0$$

2) A matritsanin' a_{ij} elementlerinin' $A_{ij} = (-1)^{i+j}$, $(i, j = 1,2,3)$ algebraliq toldiriwshilari esaplanip,

$$\widetilde{A} = \begin{pmatrix} A_{11} & A_{21} & A_{31} \\ A_{12} & A_{22} & A_{32} \\ A_{13} & A_{23} & A_{33} \end{pmatrix}$$

matritsa payda qilinadi. Bul jerde $M_{ij} - a_{ij}$ elementnin' minori.

3) Transponirlang'an matritsani tabiw.

A matritsanin' a_{ij} elementlerinin' $A_{ij} = (-1)^{i+j}$, $(i, j = 1,2,3)$ algebraliq toldiriw-shilari esaplanip,

$$\widetilde{A} = \begin{pmatrix} A_{11} & A_{21} & A_{31} \\ A_{12} & A_{22} & A_{32} \\ A_{13} & A_{23} & A_{33} \end{pmatrix}$$

matritsa payda qilinadi. Bul jerde $M_{ij} - a_{ij}$ elementtin' minori.

4) Keri matritsani tabiw

$$A^{-1} = \frac{1}{\Delta} \cdot \widetilde{A} = \begin{pmatrix} \frac{A_{11}}{\Delta} & \frac{A_{21}}{\Delta} & \frac{A_{31}}{\Delta} \\ \frac{A_{12}}{\Delta} & \frac{A_{22}}{\Delta} & \frac{A_{32}}{\Delta} \\ \frac{A_{13}}{\Delta} & \frac{A_{23}}{\Delta} & \frac{A_{33}}{\Delta} \end{pmatrix}$$

formula arqali aniqlanadi.

Demek, joqarida atap o'tilgenidey, da'slep,

$A = \begin{pmatrix} 3 & -2 & 4 \\ 2 & 4 & -5 \\ -7 & 1 & -8 \end{pmatrix}$ matritsag'a keri bolg'an A^{-1} matritsani aniqlaymiz. Bizge belgili,

$$\Delta = \begin{vmatrix} 3 & -2 & 4 \\ 2 & 4 & -5 \\ -7 & 1 & -8 \end{vmatrix} = -63 \neq 0$$

$\widetilde{A}$ matritsani du'ziw ushin $A_{ij}(i, j = 1,2,3)$ algebraliq toldiriwshilardi aniqlaymiz.

$$A_{11} = (-1)^{1+1} \begin{vmatrix} 4 & -5 \\ 1 & -8 \end{vmatrix} = -27, \quad A_{23} = (-1)^{2+3} \begin{vmatrix} 3 & -2 \\ -7 & 1 \end{vmatrix} = 11,$$

$$A_{12} = (-1)^{1+2} \begin{vmatrix} 2 & -5 \\ -7 & -8 \end{vmatrix} = 51, \quad A_{31} = (-1)^{3+1} \begin{vmatrix} -2 & 4 \\ 4 & -5 \end{vmatrix} = -6,$$

$$A_{13} = (-1)^{1+3} \begin{vmatrix} 2 & 4 \\ -7 & 1 \end{vmatrix} = 30, \quad A_{32} = (-1)^{3+2} \begin{vmatrix} 3 & 4 \\ 2 & -5 \end{vmatrix} = 23,$$

$$A_{21} = (-1)^{2+1} \begin{vmatrix} 2 & 4 \\ 1 & -8 \end{vmatrix} = -12, \quad A_{33} = (-1)^{3+3} \begin{vmatrix} 3 & -2 \\ 2 & 4 \end{vmatrix} = 16$$

$$A_{22} = (-1)^{2+2} \begin{vmatrix} 3 & 4 \\ -7 & -8 \end{vmatrix} = 4$$

Izlengen keri matritsa $A^{-1} = \frac{1}{\Delta} \cdot \widetilde{A} = \frac{1}{-63} \begin{pmatrix} -27 & -12 & -6 \\ 51 & 4 & 23 \\ 30 & 11 & 16 \end{pmatrix}$ ko'riniske iye boladi. Sonday qilip, $X = A^{-1} \cdot B$ formulag'a tiykarinan

$$X = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \frac{1}{-63} \begin{pmatrix} -27 & -12 & -6 \\ 51 & 4 & 23 \\ 30 & 11 & 16 \end{pmatrix} \cdot \begin{pmatrix} 4 \\ -15 \\ -9 \end{pmatrix} = \frac{1}{-63} \begin{pmatrix} -27 \cdot 4 + (-12) \cdot (-15) + (-6) \cdot (-9) \\ 51 \cdot 4 + 4 \cdot (-15) + 23 \cdot (-9) \\ 30 \cdot 4 + 11 \cdot (-15) + 16 \cdot (-9) \end{pmatrix} = \frac{1}{-63} \begin{pmatrix} 126 \\ -63 \\ -189 \end{pmatrix} = \begin{pmatrix} -2 \\ 1 \\ 3 \end{pmatrix}$$

ni tabamiz. Demek, $x_1 = -2,\ x_2 = -1,\ x_3 = -3$ eki usulda ha'm birdey sheshimdi alamiz.

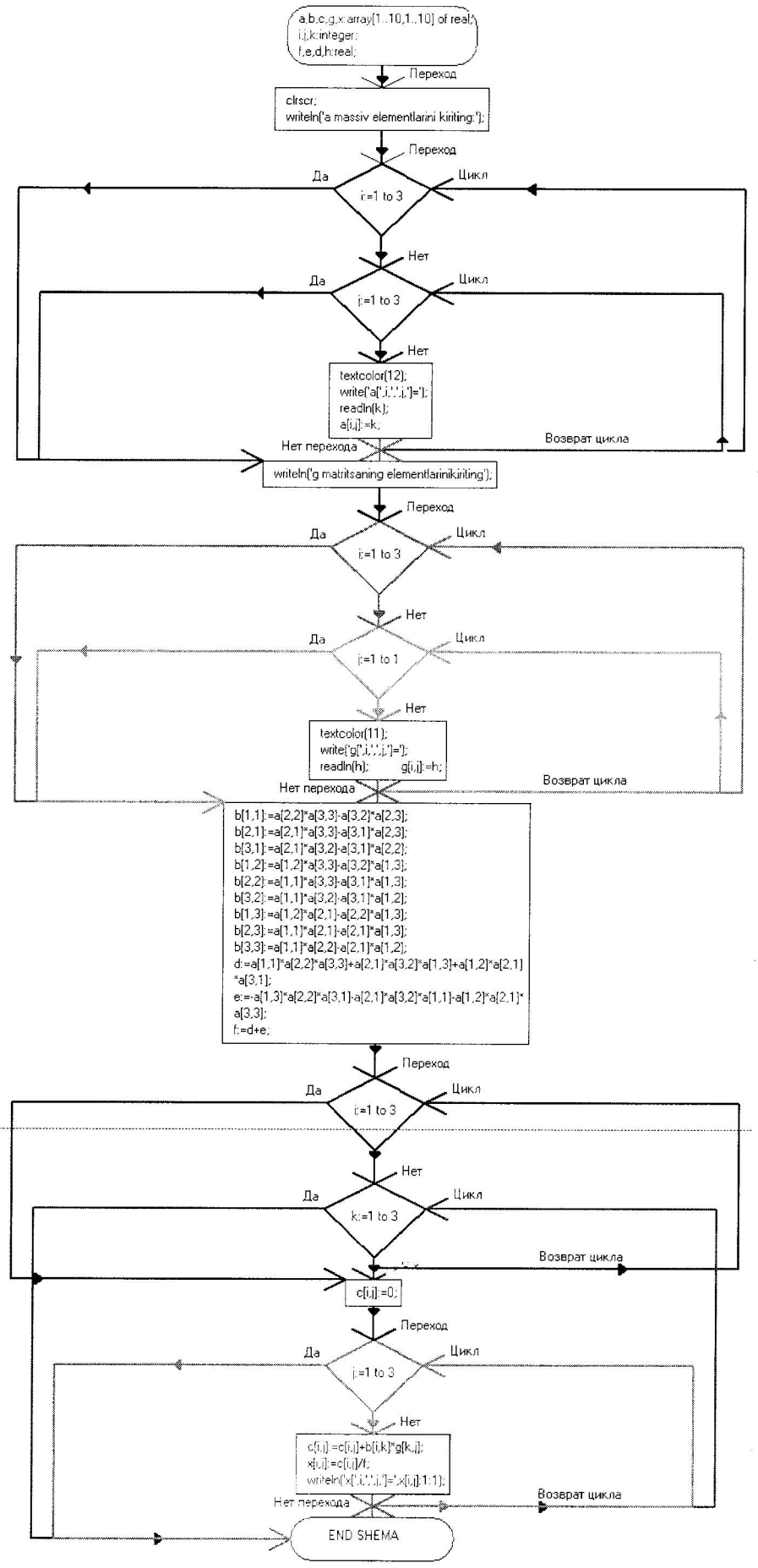
Juwap: $\{-2,1,3\}$

Keri matritsag'a du'zilgen programmalar

```
Program Keri;
uses crt;
var
 a,b,c,g,x:array[1..10,1..10] of real;
  i,j,k:integer;
f,e,d,h:real;
 begin
  clrscr;
  Writeln('A massiv elementlerin kiritin':');
  for i:=1 to 3 do
  for j:=1 to 3  do
  begin
   textcolor(12);
   Write('a[',i,',',j,']=');
   readln(k);
   a[i,j]:=k;
  end;
   begin
     writeln('G matritsanin' elementlerin kiritin'');
    for i:=1 to 3 do
    for j:=1 to 1 do
    begin
     textcolor(11);
     Write('G[',i,',',j,']=');
     readln(h);          g[i,j]:=h;
    end;
   begin
   b[1,1]:=a[2,2]*a[3,3]-a[3,2]*a[2,3];
   b[2,1]:=a[2,1]*a[3,3]-a[3,1]*a[2,3];
```

```
b[3,1]:=a[2,1]*a[3,2]-a[3,1]*a[2,2];
b[1,2]:=a[1,2]*a[3,3]-a[3,2]*a[1,3];
b[2,2]:=a[1,1]*a[3,3]-a[3,1]*a[1,3];
b[3,2]:=a[1,1]*a[3,2]-a[3,1]*a[1,2];
b[1,3]:=a[1,2]*a[2,1]-a[2,2]*a[1,3];
b[2,3]:=a[1,1]*a[2,1]-a[2,1]*a[1,3];
b[3,3]:=a[1,1]*a[2,2]-a[2,1]*a[1,2];
d:=a[1,1]*a[2,2]*a[3,3]+a[2,1]*a[3,2]*a[1,3]+a[1,2]*a[2,1]*a[3,1];
e:=-a[1,3]*a[2,2]*a[3,1]-a[2,1]*a[3,2]*a[1,1]-a[1,2]*a[2,1]*a[3,3];
f:=d+e;
for i:=1 to 3 do
begin
for k:=1 to 3 do
begin
c[i,j]:=0;
for j:=1 to 3 do begin
c[i,j]:=c[i,j]+b[i,k]*g[k,j];
      x[i,j]:=c[i,j]/f;
       Writeln('x[',i,',',j,']=',x[i,j]:1:1);
      end;          end;          end;          end;
      end;          end.
```

Keri matritsa usulinda sheshiwdin' blok sxemasi



2-Ta'jriybe jumisi.
Siziqli algebraliq ten'lemeler sistemasin Gauss usuli menen sheshiw

Usi siziqli to`rt belgisiz to`rt ten'lemeler sistemasi berilgen bolsin:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + a_{14}x_4 = a_{15} \\ a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + a_{24}x_4 = a_{25} \\ a_{31}x_1 + a_{32}x_2 + a_{33}x_3 + a_{34}x_4 = a_{35} \\ a_{41}x_1 + a_{42}x_2 + a_{43}x_3 + a_{44}x_4 = a_{45} \end{cases} \qquad (1)$$

Meyli $a_{11} \neq 0$ (jetekshi element) bolsin (eger $a_{11} = 0$ bolsa x_1 belgisiz aldindag'i koeffisienti no'l bolmag'an ten'leme menen birinshi ten'lemeni almastiramiz).

Birinshi ten'lemenin' barliq koeffisientlarin a_{11} g'a bo`lsek:

$$x_1 + \frac{a_{12}}{a_{11}}x_2 + \frac{a_{13}}{a_{11}}x_3 + \frac{a_{14}}{a_{11}}x_4 = \frac{a_{15}}{a_{11}} \qquad \text{yamasa} \quad x_1 + b_{12}^{(1)}x_2 + b_{13}^{(1)}x_3 + b_{14}^{(1)}x_4 = b_{15}^{(1)} \qquad (2)$$

payda boladi, bul jerde $b_{1j}^{(1)} = \frac{a_{1j}}{a_{11}}$ (j≥2)

Endi (2) ni a_{21} ge ko`beytirip (1) sistemanin' ekinshi ten'lemesinen, (2) ni $a_{31}$ ge ko`beytirip, sol sistemanin' u'shinshi ten'lemesinen ha'm aqiri (2) ni a_{41} ge ko`beytirip (1) sistemanin' to`rtinshi ten'lemesinen ayirip, to'mendegi ten'lemeler sistemasin payda qilamiz:

$$\begin{cases} a_{22}^{(1)}x_2 + a_{23}^{(1)}x_3 + a_{24}^{(1)}x_4 = a_{25}^{(1)} \\ a_{32}^{(1)}x_2 + a_{33}^{(1)}x_3 + a_{34}^{(1)}x_4 = a_{35}^{(1)} \\ a_{42}^{(1)}x_2 + a_{43}^{(1)}x_3 + a_{44}^{(1)}x_4 = a_{45}^{(1)} \end{cases} \qquad (3)$$

bul jerde $a_{ij}^{(1)} = a_{ij} - a_{i1} \cdot b_{1j}^{(1)}$,$(i, j \geq 2)$. (3) sistemanin' jetekshi elementi $a_{22}^{(1)} \neq 0$ dep oylap , birinshi ten'lemenin' barliq koeffisientlerin $a_{22}^{(1)}$ ga bo`lip, to'mendegini payda qilamiz:

$$x_2 + b_{a3}^{(2)}x_3 + b_{2\cdot 4}^{(2)} = b_{25}^{(2)}; \qquad (4) \qquad \text{bul jerde } b_{2j}^{(2)} = \frac{a_{2j}^{(1)}}{a_{22}^{(1)}}, (j \geq 3)$$

Endi (4) ni izbe-iz $a_{32}^{(1)}, a_{42}^{(1)}$ larga ko`beytirip, (3) sistemanin' ekinshi ha'm u'shinshi ten'lemelerden ayiramiz.

$$\begin{cases} a_{33}^{(2)}x_3 + a_{34}^{(2)}x_4 = a_{35}^{(2)} \\ a_{43}^{(2)}x_3 + a_{44}^{(2)}x_4 = a_{45}^{(2)} \end{cases}$$ (5) bul jerde $a_{ij}^{(2)} = a_{ij}^{(1)} - a_{i2}^{(1)} \cdot b_{2j}^{(2)}, (ij \geq 3)$ (5) nin' birinchi tenglamasida $a_{33}^{(2)} \neq 0$ deb (yetakchi element) faraz qilib birinchi tenglamaning barcha elementlarini $a_{33}^{(2)}$ ga bo`lsak: $x_3 + b_{34}^{(3)}x_4 = b_{35}^{(3)}$ (6) tenglama hosil bo`ladi, bu yerda $b_{3j}^{(2)} = \frac{a_{3j}^{(2)}}{a_{33}^{(2)}}, (j \geq 4)$ (6) ni $a_{43}^{(2)}$ ga ko`paytirib (5) ning ikkinchi tenglamasidan ayirsak $a_{44}^{(3)}x_4 = a_{45}^{(3)}$ (7) hosil bo`ladi, bu yerga $a_{ij}^{(3)} = a_{ij}^{(2)} - a_{i3}^{(2)} \cdot b_{3j}^{(3)}, (i, j \geq 4)$ x_4 ni (7) tenglikdan topamiz: $x_4 = \frac{a_{45}^{(3)}}{a_{44}^{(3)}} = b_{45}^{(4)}$ (6), (4), (2) lardan foydalanib x_3, x_2, x_1 – larni topamiz:

$$\left.\begin{aligned} x_3 &= b_{35}^{(3)} - b_{34}^{(3)} \cdot x_4 \\ x_2 &= b_{25}^{(2)} - b_{24}^{(2)}x_4 - b_{23}^{(2)}x_3 \\ x_1 &= b_{15}^{(1)} - b_{14}^{(1)}x_4 - b_{13}^{(1)}x_3 - b_{12}^{(1)}x_2 \end{aligned}\right\} \quad (8)$$

Ten'lemeler sistemasining yuqorida ko`rsatilgan kabi usul menen yechilishi, ya'ni navbat menen $x_1, x_2, x_3$ noma'lumlarni yo`qotib boorish usuli menen yechilishi, ten'lemeler sistemasini yechishning Gauss usuli deb ataladi.

Quyida ten'lemeler sistemasini Gauss usuli menen yechish sxemasini ko`rsatamiz. Hisoblashda xatoga yo`l qo`ymaslik ushin hisoblash jarayonini nazorat qilish ma'quldir. Buning ushin har bir satrning elementlari yig`indisi topiladi.

x_1	x_2	x_3	x_4	Ozod ag'za	$\sum$	Formulalar	Sistema bo`limi
a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}		1 A
a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}		
a_{31}	a_{32}	a_{33}	a_{34}	a_{35}	a_{36}		
a_{41}	a_{42}	a_{43}	a_{44}	a_{45}	a_{46}		
1	$b_{12}^{(1)}$	$b_{13}^{(1)}$	$b_{14}^{(1)}$	$b_{15}^{(1)}$	$b_{16}^{(1)}$	$b_{ij}^{(1)} = \frac{a_{ij}}{a_{11}}, (j \geq 2)$	2
	$a_{22}^{(1)}$	$a_{23}^{(1)}$	$a_{24}^{(1)}$	$a_{25}^{(1)}$	$a_{26}^{(1)}$	$a_{ij}^{(1)} = a_{ij} - a_{i1} \cdot b_{1j}^{(1)}$	
	$a_{32}^{(1)}$	$a_{33}^{(1)}$	$a_{34}^{(1)}$	$a_{35}^{(1)}$	$a_{36}^{(1)}$	$a_{24}^{(1)} = a_{24} - a_{21} \cdot b_{14}^{(1)}$	1
	$a_{42}^{(1)}$	$a_{43}^{(1)}$	$a_{44}^{(1)}$	$a_{45}^{(1)}$	$a_{46}^{(1)}$	$(i, j \geq 2)$	A_1
	1	$b_{23}^{(2)}$	$b_{24}^{(2)}$	$b_{25}^{(2)}$	$b_{26}^{(2)}$	$b_{2j}^{(2)} = \frac{a_{2j}^{(1)}}{a_{22}^{(1)}} \quad (j \geq 3)$	2
		$a_{33}^{(2)}$	$a_{34}^{(2)}$	$a_{35}^{(2)}$	$a_{36}^{(2)}$	$a_{ij}^{(2)} = a_{ij}^{(1)} - a_{i2}^{(1)} \cdot b_{2j}^{(2)}$	1
		$a_{43}^{(2)}$	$a_{44}^{(2)}$	$a_{45}^{(2)}$	$a_{46}^{(2)}$	$a_{43}^{(2)} = a_{43}^{(1)} - a_{42}^{(1)} \cdot b_{23}^{(2)}$	A_2
		1	$b_{34}^{(3)}$	$b_{35}^{(3)}$	$b_{36}^{(3)}$	$b_{3j} = \frac{a_{3j}^{(2)}}{a_{33}^{(2)}} (j \geq 4)$	2
			$a_{44}^{(3)}$	$a_{45}^{(3)}$	$a_{46}^{(3)}$	$a_{ij}^{(3)} = a_{ij}^{(2)} - a_{i3}^{2} \cdot b_{3j}^{(3)}$	1
			1	$b_{45}^{(4)}$	$b_{46}^{(4)}$	$b_{4j}^{(4)} = \frac{a_{4j}^{(3)}}{a_{44}^{(3)}} (j \geq 5)$	A_3 2
			1	x_4	$\bar{x}_4$	$x_4 = b_{45}^{(4)}$	
		1		x_3	$\bar{x}_3$	$x_3 = b_{35}^{(3)} - b_{34}^{(3)} \cdot x_4$	
	1			x_2	$\bar{x}_2$	$x_2 = b_{25}^{(2)} - b_{24}^{(2)} \cdot x_4 - b_{23}^{(2)} \cdot x_3$	B
1				x_1	$\bar{x}_1$	$x_1 = b_{15}^{(1)} - b_{14}^{(1)} \cdot x_4 - b_{13}^{(1)} \cdot x_3 - b_{12}^{(1)} \cdot x_2$	

U'lgili misal

Misal. To'mendegi algebraliq ten'lemeler sistemasin sheshilsin:

$$\begin{cases} 3{,}4x_1 + 2x_2 - 5{,}6x_3 + 4{,}8x_4 = 6{,}21 \\ 2{,}4x_1 - 3{,}7x_2 + 8{,}5x_3 - 5{,}9x_4 = 5{,}73 \\ 9{,}3x_1 + 8{,}9x_2 - 3{,}3x_3 - 0{,}6x_4 = 2{,}5 \\ 0{,}7x_1 - 7{,}4x_2 + 4{,}1x_3 + 5{,}8x_4 = 3{,}4 \end{cases}$$

Sheshiw: Sxemanin‘ A bo’liminin‘ 1-bo‘limine belgisiz aldindag‘i koeffitsientlerin, ozod ag‘zalardi ha’m kontrol qosindini jazamiz. 1-qatardin‘ barliq elementlerin 3,4 ke bo’lip, A bo’limnin‘ ekinshi bo‘limin to’ltiramiz.

A – bo’limnin‘ 1-bo‘limin to’ltiriw ushin onin‘ elementlerin to‘mendegishe tawamiz: A bo’limnin‘ 1-bolimindegi 1-qatarda turg‘an ixtiyoriy elementinen, usi element turg‘an qatardin‘ birinshi elementi menen, usi element turg‘an ustunning aqirg‘i elementi ko’beytpesin ayirip, A bo’limnin‘ 1-bo‘limindegi tuwra keletug’in ornina jazamiz.

$$a_{22}^{(1)} = a_{22} - a_{21} \cdot b_{13}^{(1)} = -3,7 - 2,4 \cdot 0,588 = -5,1112$$
$$a_{23}^{(1)} = a_{23} - a_{21} \cdot b_{13}^{(1)} = 8,5 - 2,4(-1,647) = 12,4528$$
$$a_{34}^{(1)} = a_{34} - a_{31} \cdot b_{14}^{(1)} = -0,6 - 9,3 \cdot 1,412 = -13,7316$$

A_1 bo’limnin’ 2-bo’limin tabiw ushin 1-bo’limnin’ 1-qatarinin’ barliq elementlerin $-5,1112$ ge bo’lemiz.

A_2, A_3 – bo’limler ha’m A_1-bo’lim toltirilg’aniday toltiriladi. Belgisizlerin tabiw ushin, birinshi koeffisienti 1 ge ten’ bolg’an qatarlardan paydalanamiz. x_4 – A_3 bo’limnin’ aqirg’i elementi :

$a_4 = b_{45}^{(4)} = -1,6564$ x_1, x_2, x_3 lerdi to’menidegishe esaplaymiz:

$$x_3 = b_{35}^{(3)} - b_{34}^{(3)} x_4 = -0,666 + 0,9799(-1,6564) = -2,2894,$$
$$x_2 = b_{25}^{(2)} - b_{24}^{(2)} x_4 - b_{23}^{(2)} x_3 = -0,2637 - 1,8173 \cdot (-1,6564) + 2,4364 \cdot (-2,2894) = -2,8314$$
$$x_1 = b_{15}^{(1)} - b_{14}^{(1)} x_4 - b_{13}^{(1)} x_3 - b_{12}^{(1)} x_2 = 1,826 - 1,412 \cdot (-1,6564) - 1,647 \cdot (-2,2894) - 0,588 \cdot (-2,8314) = 2,0591$$

Endi $x_1 = 2,0591$, $x_2 = -2,8314$, $x_3 = -2,2894$, $x_4 = -1,6564$ to’mendegilerdi sxemag’a jazamiz. Belgisizlerinin’ tabilg’an bul ma’nislerin berilgen sistemag’a qoyip, tekseremiz.

Juwap: $x_1 = 2,0591$, $x_2 = -2,8314$, $x_3 = -2,2894$, $x_4 = -1,6564$

x_1	x_2	x_3	x_4	*Ozod ag’zalari*	*Qosindi* $\sum_{k=1}^{5} x_k$	*Bo’limler*
3,4	2	-5,6	4,8	6,21	10,81	A
2,4	-3,7	8,5	-5,9	5,73	7,63	
9,3	8,9	-3,3	-0,6	2,5	16,8	
0,7	-7,4	4,1	5,8	3,4	3,4	
1	0,588	-1,647	1,412	1,826	3,179	A_1
	-	12,452	-	1,3476	-0,5996	
	5,111	8	9,2888			

	2					
	3,4316	12,0171	-13,731	-14,4818	-12,7647	
	-7,8116	5,2529	4,8116	2,1218	4,3747	
	1	-2,4364	1,8173	-0,2637	0,1173	
		20,3779	-19,9678	-13,5769	-13,1672	A_2
		-13,7793	19,0076	0,0619	5,2910	
		1	-0,9799	-0,6663	-0,6462	A_3
			5,5053	-9,1192	-3,6139	
			1	-1,6564	-0,6564	
			1	-1,6564	-0,6564	
		1		-2,2894	-1,1894	
	1			-2,8314	-1,8314	
1				2,0591	3,0591	

Gauss usulina du'zilgen programma

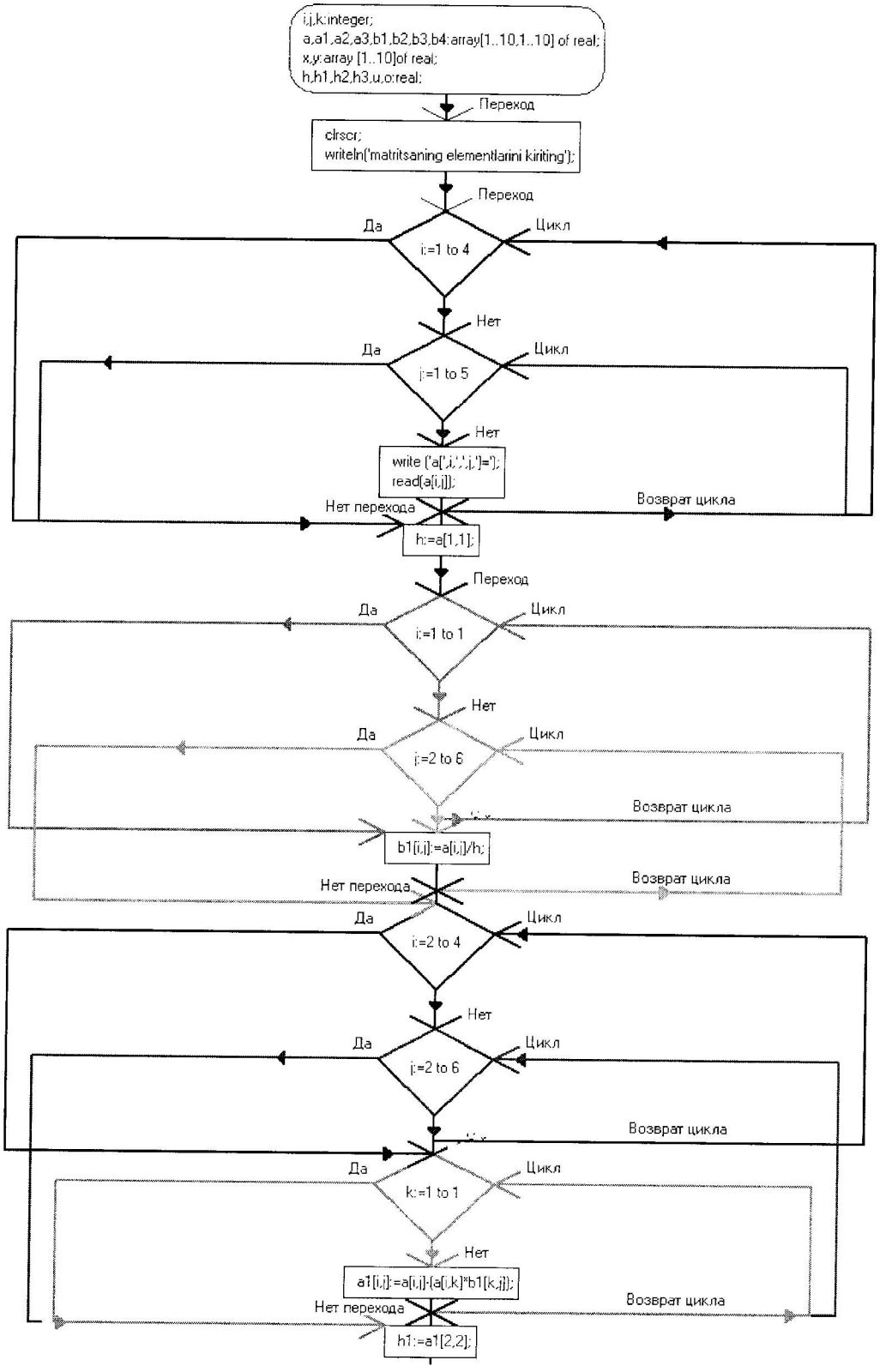
```
program gauss;
uses crt;
var i,j,k:integer;
a,a1,a2,a3,b1,b2,b3,b4:array[1..10,1..10] of real;
x,y:array [1..10]of real;
h,h1,h2,h3,u,o:real;
begin
   clrscr;
   writeln('Matritsanin' elementlerin kiritin'');
   for i:=1 to 4 do begin
   for j:=1 to 5 do begin
   write ('a[',i,',',j,']=');
   read(a[i,j]);
   end;
   end;
   begin
   h:=a[1,1];
   begin
   for i:=1 to 1 do begin
   for j:=2 to 6 do begin
   b1[i,j]:=a[i,j]/h;
  end;   end;   end;
    begin
    for i:=2 to 4 do begin
    for j:=2 to 6 do begin
    for k:=1 to 1 do begin
    a1[i,j]:=a[i,j]-(a[i,k]*b1[k,j]);
    end;     end;     end;
    end;
```

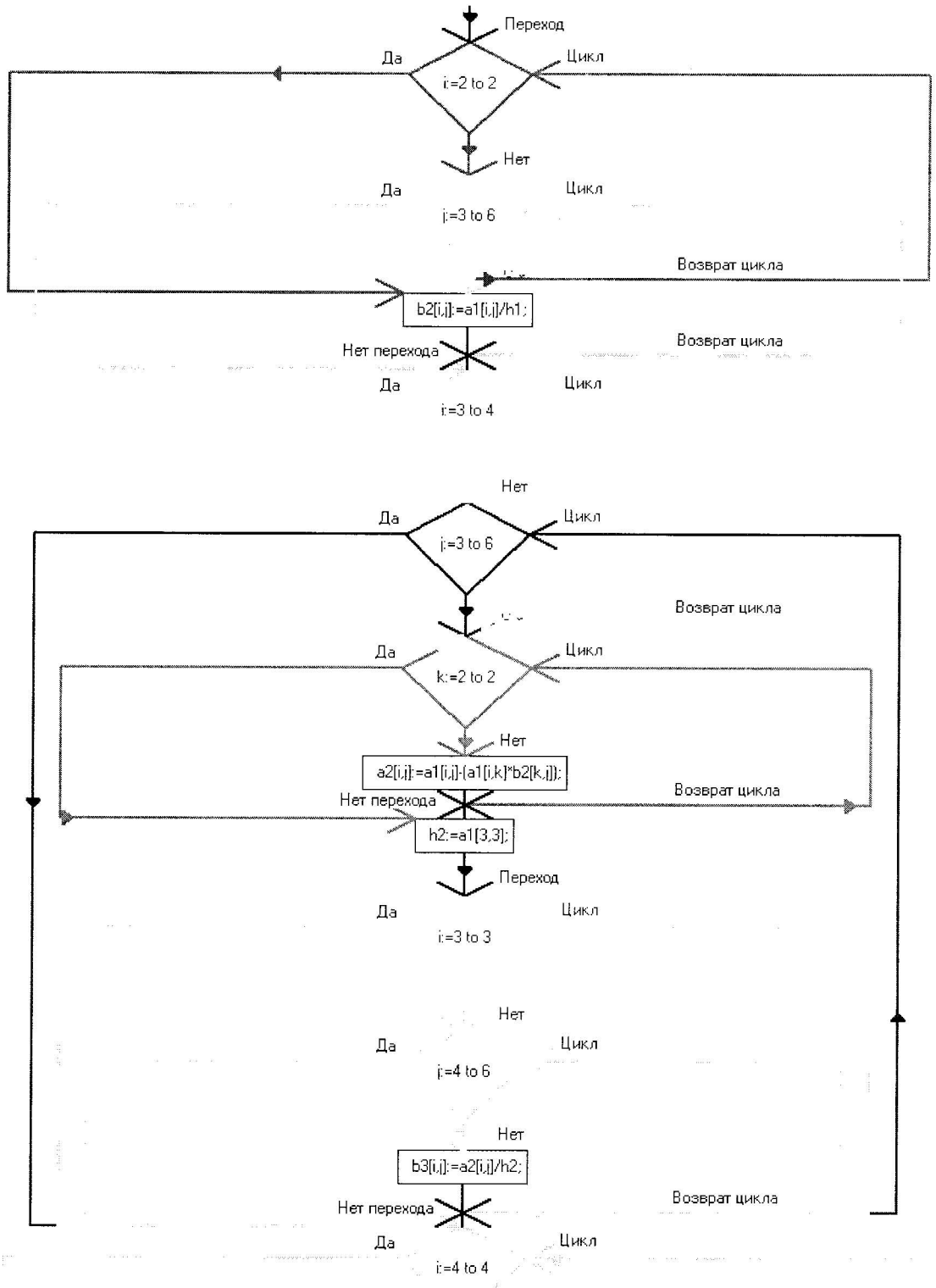
```
begin
h1:=a1[2,2];
 begin
 for i:=2 to 2 do begin
 for j:=3 to 6 do begin
 b2[i,j]:=a1[i,j]/h1;
 end;    end;    end;
 begin
  for i:=3 to 4 do begin
  for j:=3 to 6 do begin
  for k:=2 to 2 do begin
  a2[i,j]:=a1[i,j]-(a1[i,k]*b2[k,j]);
  end;      end;      end;      end;
  begin
     h2:=a1[3,3];
     begin
     for i:=3 to 3 do begin
     for j:=4 to 6 do begin
     b3[i,j]:=a2[i,j]/h2;
     end;
     end;
     end;
     begin
  for i:=4 to 4 do begin
  for j:=4 to 6 do begin
  for k:=3 to 3 do begin
  a3[i,j]:=a2[i,j]-(a2[i,k]*b3[k,j]);
  end;      end;      end;      end;
  begin
  h3:=a3[4,4];
```

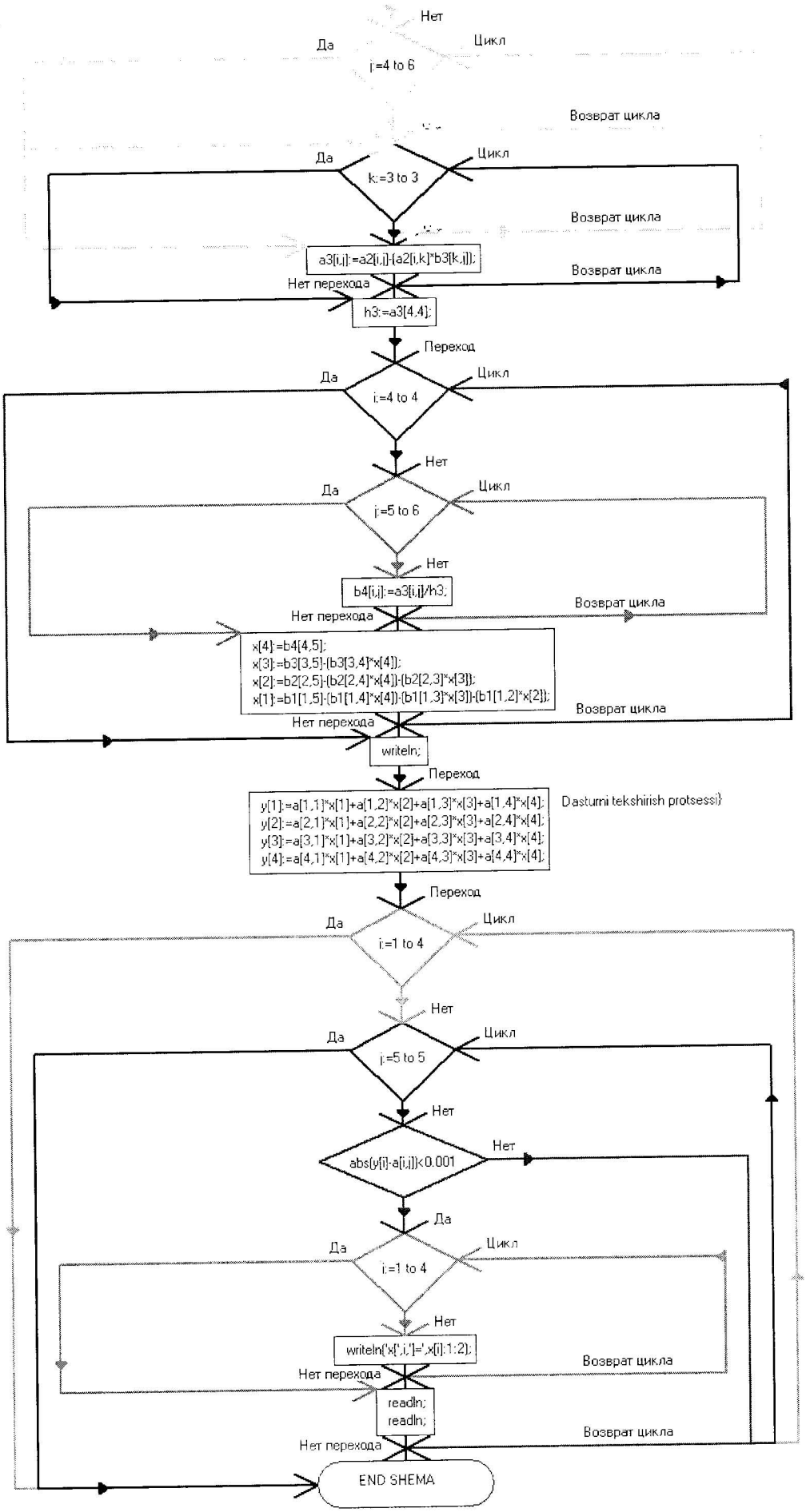
```
begin
for i:=4 to 4 do begin
for j:=5 to 6 do begin
b4[i,j]:=a3[i,j]/h3;
end;      end;
begin
x[4]:=b4[4,5];
x[3]:=b3[3,5]-(b3[3,4]*x[4]);
x[2]:=b2[2,5]-(b2[2,4]*x[4])-(b2[2,3]*x[3]);
x[1]:=b1[1,5]-(b1[1,4]*x[4])-(b1[1,3]*x[3])-(b1[1,2]*x[2]);
end;
writeln;
begin
{programmani tekseriw protsessi}

y[1]:=a[1,1]*x[1]+a[1,2]*x[2]+a[1,3]*x[3]+a[1,4]*x[4];
y[2]:=a[2,1]*x[1]+a[2,2]*x[2]+a[2,3]*x[3]+a[2,4]*x[4];
y[3]:=a[3,1]*x[1]+a[3,2]*x[2]+a[3,3]*x[3]+a[3,4]*x[4];
y[4]:=a[4,1]*x[1]+a[4,2]*x[2]+a[4,3]*x[3]+a[4,4]*x[4];
    for i:=1 to 4 do begin
    for j:=1 to 5 do begin
    if abs(y[i]-a[i,j])<0.001 then
    begin
    for i:=1 to 4 do begin
       writeln('x[',i,']=',x[i]:1:2);
end;
readln;
readln;
end;      end;      end;      end;
   end;      end;      end;      end;
end;      end.
```

Gauss usulinda sheshiwdin' blok sxemasi.




Переход
Да
Цикл
i:=2 to 2
Нет
Да
Цикл
j:=3 to 6
Возврат цикла
b2[i,j]:=a1[i,j]/h1;
Нет перехода
Возврат цикла
Да
Цикл
i:=3 to 4
Нет
Да
Цикл
j:=3 to 6
Возврат цикла
Да
Цикл
k:=2 to 2
Нет
a2[i,j]:=a1[i,j]-(a1[i,k]*b2[k,j]);
Нет перехода
Возврат цикла
h2:=a1[3,3];
Переход
Да
Цикл
i:=3 to 3
Нет
Да
Цикл
j:=4 to 6
Нет
b3[i,j]:=a2[i,j]/h2;
Нет перехода
Возврат цикла
Да
Цикл
i:=4 to 4


Нет
Да
Цикл
j:=4 to 6
Возврат цикла
Да
Цикл
k:=3 to 3
Возврат цикла
a3[i,j]:=a2[i,j]-(a2[i,k]*b3[k,j]);
Возврат цикла
Нет перехода
h3:=a3[4,4];
Переход
Да
Цикл
i:=4 to 4
Нет
Да
Цикл
j:=5 to 6
Нет
b4[i,j]:=a3[i,j]/h3;
Возврат цикла
Нет перехода
x[4]:=b4[4,5];
x[3]:=b3[3,5]-(b3[3,4]*x[4]);
x[2]:=b2[2,5]-(b2[2,4]*x[4])-(b2[2,3]*x[3]);
x[1]:=b1[1,5]-(b1[1,4]*x[4])-(b1[1,3]*x[3])-(b1[1,2]*x[2]);
Возврат цикла
Нет перехода
writeln;
Переход
y[1]:=a[1,1]*x[1]+a[1,2]*x[2]+a[1,3]*x[3]+a[1,4]*x[4];
y[2]:=a[2,1]*x[1]+a[2,2]*x[2]+a[2,3]*x[3]+a[2,4]*x[4];
y[3]:=a[3,1]*x[1]+a[3,2]*x[2]+a[3,3]*x[3]+a[3,4]*x[4];
y[4]:=a[4,1]*x[1]+a[4,2]*x[2]+a[4,3]*x[3]+a[4,4]*x[4];
Dasturni tekshirish protsessi
Переход
Да
Цикл
i:=1 to 4
Нет
Да
Цикл
j:=5 to 5
Нет
Нет
abs(y[i]-a[i,j])<0.001
Да
Да
Цикл
i:=1 to 4
Нет
writeln('x[',i,']=',x[i]:1:2);
Возврат цикла
Нет перехода
readln;
readln;
Возврат цикла
Нет перехода
END SHEMA

JUWMAQ.

TURBO PASKAL TILINDE ISLEW WAQTINDA USI PROGRAMMALASTIRIW TILINDE KO'PLEGEN MATEMATIKALIQ MASELELER MENEN ISLEWDI U'YRENDIM. TURBO PASKAL TILI PROGRAMMALASTIRIW TILLERI ISHINDE EN' A'PIWAYISI, QOLAYLISI HA'M IMKANIYATLARI KEN' TIL ESAPLANADI. BUL PROGRAMMALASTIRIW TILININ' BIR NESHE VERSIYALARI PAYDA BOLIP, HAR JAN'A VERSIYASI ALDING'ILARINAN JA'NEDE A'PIWAYI HA'M TU'SINIKLIREK.

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