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Davlat aksiyadorlik temir yo’l kompaniyasi
Toshkent Temir Yo’l Muxandislari Instituti

“Informatika va komputer grafikasi”
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1-mavzu: Chiziqli algebraik tenglamalar sistemasini yechishning Gauss usuli

Nazariy va tadbiqiy matematikaning ko‘pgina masalalari birinchi darajali chiziqli tenglamalar sistemasini yechishga olib kelinadi. Masalan, funksiyaning *n*-ta nuqtada berilgan qiymatlari yordamida *n*-tartibli ko‘phad bilan interpolyatsiyalash yoki funksiyani o‘rta kvadratlar usuli yordamida yaqinlashtirish masalalari birinchi darajali chiziqli tenglamalar sistemasini yechishga keltiriladi.

Birinchi darajali chiziqli tenglamalar sistemasini hosil qilishning manbai uzluksiz funksional tenglamalarni chekli ayirmali tenglamalar bilan yaqinlashtirishdir.

Birinchi darajali chiziqli tenglamalar sistemasini yechish asosan ikki usulga, ya’ni aniq va iteratsion usullarga bo‘linadi.

Aniq usul deganda chekli miqdordagi arifmetik amallarni aniq bajarish natijasida masalaning aniq yechimini topish tushuniladi.

Iteratsion usullarda chiziqli tenglamalar sistemasining yechimi ketma-ket yaqinlashishlarning limiti sifatida topiladi.

Chiziqli tenglamalar sistemasini yechishning noma’lumlarni ketma-ket yo‘qotish orqali aniqlash usuli, ya’ni Gauss usulini ko‘rib chiqamiz.

Bu usul bir necha hisoblash yo‘llariga ega. Shulardan biri Gaussning kompleks yo‘lidir.

Ushbu sistema berilgan bo‘lsin

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n = a_{1,n+1}, \\ a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n = a_{2,n+1}, \\ ...., \\ a_{n1}x_1 + a_{n2}x_2 + ... + a_{nn}x_n = a_{n,n+1}. \end{cases} \qquad (1)$$

Faraz qilaylik, $a_{11} \neq 0$ (etakchi element) bo‘lsin, aks holda tenglamalarning o‘rinlarini almashtirib, x_1 oldidagi koeffisienti noldan farqli bo‘lgan tenglamani birinchi o‘ringa ko‘chiramiz.

Sistemadagi birinchi tenglamaning barcha koeffisientlarini a_{11} ga bo‘lib,

$$x_1 + b_{12}^{(1)}x_2 + ... + b_{1n}^{(1)}x_n = b_{1,n+1}^{(1)} \qquad (2)$$

ni hosil qilamiz, bu yerda

$$\frac{a_{12}}{a_{11}} = b_{12}^{(1)}, \ . \ . \ . \ . \ , \frac{a_{1n}}{a_{11}} = b_{1n}^{(1)}, \ \frac{a_{1,n+1}}{a_{11}} = b_{1,n+1}^{(1)}$$

yoki qisqacha $b_{1j}^{(1)} = \frac{a_{1j}}{a_{11}} \quad (j \geq 2).$

(2) tenglamadan foydalanib, (1) sistemaning qolgan tenglamalarida x_1 ni yo‘qotish mumkin. Buning uchun (2) tenglamani ketma-ket a_{21}, a_{31}, … larga ko‘paytirib mos ravishda sistemaning ikkinchi, uchinchi va h.k. tenglamalaridan ayiramiz. Natijada, quyidagi sistema hosil bo‘ladi.

$$\begin{cases} a_{22}^{(1)} x_2 + \ldots + a_{2n}^{(1)} x_n = a_{2,n+1}^{(1)}, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ a_{n2}^{(1)} x_2 + \ldots + a_{nn}^{(1)} x_n = a_{n,n+1}^{(1)}, \end{cases} \quad (3)$$

bu yerda $a_{ij}^{(1)}$ koeffisientlar

$$a_{ij}^{(1)} = a_{ij} - a_{i1} b_{1j}^{(1)}, \; (i, j \geq 2)$$

formula yordamida hisoblanadi.

Endi (3) sistema ustida ham shunga o‘xshash almashtirishlar bajaramiz. Buning uchun (3) sistemadagi birinchi tenglamaning barcha koeffisientlarini yetakchi element $a_{22}^{(1)} \neq 0$ ga bo‘lib,

$$x_2 + b_{23}^{(2)} x_3 + \ldots + b_{2n}^{(2)} x_n = b_{2,n+1}^{(2)} \quad (4)$$

ni hosil qilamiz, bu yerda

$$b_{2j}^{(2)} = \frac{a_{2j}^{(1)}}{a_{22}^{(1)}} \; (j \geq 3)$$

(4) tenglama yordamida (3) sistemaning keyingi tenglamalarida yuqoridagidek x_2 ni yo‘qotib,

$$\begin{cases} a_{33}^{(2)} x_3 + \ldots + a_{3n}^{(2)} x_n = a_{3,n+1}^{(2)}, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots, \\ a_{n3}^{(2)} x_3 + \ldots + a_{nn}^{(2)} x_n = a_{n,n+1}^{(2)} \end{cases}$$

sistemaga kelamiz, bu yerda

$$a_{ij}^{(2)} = a_{ij}^{(1)} - a_{i2}^{(1)} b_{2j}^{(2)}, \; (i, j \geq 2)$$

Noma’lumlarni yo‘qotish jarayoni davom ettirilib, bu jarayonni m–qadamgacha bajarish mumkin deb faraz qilamiz va m – qadamda quyidagi sistemaga ega bo‘lamiz.

$$\begin{cases} x_m + b_{m,m+1}^{(m)} x_{m+1} + \ldots + b_{mn}^{(m)} x_n = b_{m,n+1}^{(m)}, \\ a_{m+1,m+1}^{(m)} x_{m+1} + \ldots + a_{m+1,n}^{(m)} x_n = a_{m,n+1}^{(m)}, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots, \\ a_{n,m+1}^{(m)} x_{m+1} + \ldots + a_{nn}^{(m)} x_n = a_{n,n+1}^{(m)}. \end{cases} \quad (5)$$

bu yerda

$$b_{mj}^{(m)} = \frac{a_{mj}^{(m)}}{a_{mm}^{(m)}},\ a_{ij}^{(m)} = a_{ij}^{(m-1)} - a_{im}^{(m-1)} b_{mj}^{(m)} \ (i,\ j \geq m+1)\ .$$

Faraz qilaylik, m mumkin bo‘lgan oxirgi qadamning nomeri bo‘lsin. Ikki hol bo‘lishi mumkin: $m=n$ yoki $m<n$. Agar $m=n$ uchburchak matritsali va (1) sistemaga ekvivalent bo‘lgan quyidagi

$$\begin{cases} x_1 + b_{12}^{(1)} x_2 + b_{13}^{(1)} x_3 + \ldots + b_{1n}^{(1)} x_n = b_{1,n+1}^{(1)}, \\ x_2 + b_{23}^{(2)} x_3 + \ldots + b_{2n}^{(2)} x_n = b_{2,n+1}^{(2)}, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots, \\ x_n = b_{n,n+1}^{(n)} \end{cases} \quad (6)$$

sistemaga ega bo‘lamiz. Oxirgi sistemadan ketma-ket $x_n, x_{n-1}, \ldots, x_1$ larni topish mumkin

$$\begin{cases} x_n = b_{n,n-1}^{(n)} \\ x_{n-1} = b_{n-1,n+1}^{(n-1)} - b_{n-1,n}^{(n-1)} x_n \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ x_1 = b_{1,n+1}^{(1)} x_2 - \ldots - b_{1,n}^{(1)} x_n. \end{cases} \quad (7)$$

(6) uchburchak sistemasining koeffisientlarini topish Gauss usulining ***to‘g‘ri yurishi***, (7) sistemadan yechimini topish Gauss usulining ***teskari yurishi*** deyiladi.

Chiziqli tenglamalar sistemasini Gauss usuli yordamida yechish algoritmi va dasturi

1-misol.

Gauss usuli bilan quyidagi sistema yechilsin.

$$\begin{cases} 2x_1 - 3x_2 + 2x_3 - 4x_4 = 5, & (8) \\ 3x_1 + x_2 - 2x_3 - 2x_4 = 4, & (9) \\ 4x_1 + 2x_2 - 3x_3 + x_4 = 2, & (10) \\ x_1 + x_2 + x_3 + x_4 = 2, & (11) \end{cases}$$

(8) tenglamadan x_1 ni topamiz

$$2x_1 - 3_2 x + 2x_3 - 4x_4 = 5,$$
$$2x_1 = 5 + 3x_2 - 2x_3 + 4x_4, \qquad (12)$$
$$x_1 = \frac{5}{2} + \frac{3}{2}x_2 - x_3 + 2x_4,$$

(12) tenglamani (9) tenglamadagi x_1 ni o‘rniga qo‘yamiz va uni ixchamlaymiz.

$$3x_1 + x_2 - 2x_3 - 2x_4 = 4,$$
$$3\left(\frac{5}{2} + \frac{3}{2}x_2 - x_3 + 2x_4\right) + x_2 - 2x_3 - 2x_4 = 4,$$
$$\frac{15}{2} + \frac{9}{2}x_2 - 3x_3 + 6x._4 + x_2 - 2x_3 - 2x_4 = 4,$$
$$15 + 9x_2 - 6x_3 + 12x_4 + 2x_2 - 4x_3 - 4x_4 = 8,$$
$$11x_2 - 10x_3 + 8x_4 = -7.$$

(12) tenglamani (10) tenglamadagi x_1 ni o‘rniga qo‘yamiz va uni ixchamlaymiz.

$$4x_1 + 2x_2 - 3x_3 + x_4 = 2,$$
$$4\left(\frac{5}{2} + \frac{3}{2}x_2 - x_3 + 2x_4\right) + 2x_2 - 3x_3 + x_4 = 2,$$
$$10 + 6x_2 - 4x_3 + 8x_4 + 2x_2 - 3x_3 + x_4 = 2,$$
$$8x_2 - 7x_3 + 9x_3 = -8.$$

(12) tenglamani (11) tenglamadagi x_1 ni o‘rniga qo‘yamiz va uni ixchamlaymiz.

$$x_1 + x_2 + x_3 + x_4 = 2,$$
$$\frac{5}{2} + \frac{3}{2}x_2 - x_3 + 2x_4 + x_2 + x_3 + x_4 = 2,$$
$$5 + 3x_2 - 2x_3 + 4x_4 + 2x_2 + 2x_3 + 2x_4 = 4,$$
$$5x_2 + 6x_4 = -1.$$

Yuqoridagilardan quyidagi yangi tenglamalar sistemasini hosil qilamiz

$$\begin{cases} 2x_1 - 3x_2 + 2x_3 - 4x_4 = 5, & \\ 11x_2 - 10x_3 + 8x_4 = -7, & (13) \\ 8x_2 - 7x_3 + 9x_4 = -8, & (14) \\ 5x_2 + 6x_4 = -1. & (15) \end{cases}$$

(13) tenglamadan x_2 ni topamiz

$$11x_2 - 10x_3 + 8x_4 = -7,$$
$$11x_2 = -7 + 10x_3 - 8x_4, \qquad (16)$$
$$x_2 = -\frac{7}{11} + \frac{10}{11}x_3 - \frac{8}{11}x_4,$$

(16) tenglamani (14) tenglamadagi x_2 ni o‘rniga qo‘yamiz va uni ixchamlaymiz

$$
\begin{aligned}
&8x_2 - 7x_3 + 9x_4 = -8,\\
&8\left(-\frac{7}{11} + \frac{10}{11}x_3 - \frac{8}{11}x_4\right) - 7x_3 + 9x_4 = -8,\\
&-\frac{56}{11} + \frac{80}{11}x_3 - \frac{64}{11}x_4 - 7x_3 + 9x_4 = -8, \qquad (15)\\
&-56 + 80x_3 - 64x_4 - 77x_3 + 99x_4 = -88,\\
&3x_3 + 35x_4 = -32,
\end{aligned}
$$

(16) tenglamani (15) tenglamadagi x_2 ni o‘rniga qo‘yamiz va uni ixchamlaymiz

$$
\begin{aligned}
&5x_2 + 6x_4 = -1,\\
&5\left(-\frac{7}{11} + \frac{10}{11}x_3 - \frac{8}{11}x_4\right) + 6x_4 = -1,\\
&-\frac{35}{11} + \frac{50}{11}x_3 - \frac{40}{11}x_4 + 6x_4 = -1,\\
&-35 + 50x_3 - 40x_4 + 66x_4 = -11,\\
&50x_3 + 26x_4 = 24,\\
&25x_3 + 13x_4 = 12.
\end{aligned}
$$

Yuqoridagilardan qo‘yidagi yangi tenglamalar sistemasini hosil qilamiz

$$
\begin{cases}
2x_1 - 3x_2 + 2x_3 - 4x_4 = 5,\\
11x_2 - 10x_3 + 8x_4 = -7,\\
3x_3 + 35x_4 = -32, & (17)\\
25x_3 + 13x_4 = 12. & (18)
\end{cases}
$$

(17) tenglamadan x_3 ni topamiz

$$
\begin{aligned}
&3x_3 + 35x_4 = -32,\\
&3x_3 = -32 - 35x_4, \qquad (19)\\
&x_3 = -\frac{32}{3} - \frac{35}{3}x_4.
\end{aligned}
$$

(19) tenglamani (18) tenglamadagi x_3 ni o‘rniga qo‘yamiz va uni ixchamlaymiz

$$
\begin{aligned}
&25x_3 + 13x_4 = 12,\\
&25\left(-\frac{32}{3} - \frac{35}{3}x_4\right) + 13x_4 = 12,\\
&-\frac{800}{3} - \frac{875}{3}x_4 + 13x_4 = 12, \qquad (20)\\
&-800 - 875x_4 + 13x_4 = 36,\\
&-836x_4 = 836,\\
&[x_4 = -1].
\end{aligned}
$$

(20) tenglamaning qiymatini (19) tenglamadagi x_4 ni o‘rniga qo‘yib x_3 ni topamiz.

$$x_3 = -\frac{32}{3} - \frac{35}{3}x_4 = -\frac{32}{3} + \frac{35}{3} = 1, \qquad (21)$$
$$[x_3 = 1].$$

(21) va (20) qiymatlarini (18) tenglamadagi x_3 va x_4 ni o‘rniga qo‘yib x_2 ni topamiz.

$$x_2 = -\frac{7}{11} + \frac{10}{11}x_3 - \frac{8}{11}x_4 = -\frac{7}{11} + \frac{10}{11} + \frac{8}{11} = \frac{11}{11} = 1, \qquad (22)$$
$$[x_2 = 1].$$

(20), (21) va(22) larni qiymatlarini (12) tenglamadagi x_2, x_3 va x_4 lar ni o‘rniga qo‘yib x_1 ni topamiz.

$$x_1 = \frac{5}{2} + \frac{3}{2}x_2 - x_3 + 2x_4 = \frac{5}{2} + \frac{3}{2}\cdot 1 - 1 - 2 = 2{,}5 + 1{,}5 - 3 = 4 - 3 = 1,$$
$$[x_1 = 1].$$

Demak, topilgan ildizlar $[x_1 = 1]$,$[x_2 = 1]$, $[x_3 = 1]$, $[x_4 = -1]$ berilgan tenglamalar sistemasini to‘liq qanoatlantiradi.

Tenglamalar sistemasi qo‘lda yechilganda hisoblashlarni 1-jadvalda ko‘rsatilgan Gaussning kompakt sxemasi bo‘yicha olib borish ma’quldir.

Soddalik uchun jadvalda to‘rtta no’malumli to‘rtta tenglamalar sistemasini yechish sxemasi keltirilgan.

x_1	x_2	x_3	x_4	OZOD HADLAR	$\sum$	SXEMA QISMLARI
a_{11} a_{21} a_{31} a_{41} … 1	a_{12} a_{22} a_{32} a_{42} … $b_{12}^{(1)}$	a_{13} a_{23} a_{33} a_{43} … $b_{13}^{(1)}$	a_{14} a_{24} a_{34} a_{44} … $b_{14}^{(1)}$	a_{15} a_{25} a_{35} a_{45} … $b_{15}^{(1)}$	a_{16} a_{26} a_{36} a_{46} … $b_{16}^{(1)}$	A
	$a_{22}^{(1)}$ $a_{32}^{(1)}$ $a_{42}^{(1)}$ …	$a_{23}^{(1)}$ $a_{32}^{(1)}$ $a_{43}^{(1)}$ …	$a_{24}^{(1)}$ $a_{34}^{(1)}$ $a_{44}^{(1)}$ …	$a_{25}^{(1)}$ $a_{35}^{(1)}$ $a_{45}^{(1)}$ …	$a_{25}^{(1)}$ $a_{35}^{(1)}$ $a_{45}^{(1)}$ …	A_1

	1	$b_{23}^{(2)}$	$b_{24}^{(2)}$	$b_{25}^{(2)}$	$b_{25}^{(2)}$	
		$a_{33}^{(2)}$ $a_{43}^{(2)}$ ... 1	$a_{34}^{(2)}$ $a_{44}^{(2)}$ … $b_{34}^{(3)}$	$a_{35}^{(2)}$ $a_{45}^{(2)}$ … $b_{35}^{(3)}$	$a_{36}^{(2)}$ $a_{46}^{(2)}$ … $b_{36}^{(3)}$	A_2
			$a_{44}^{(3)}$ … 1	$a_{45}^{(3)}$ … $b_{45}^{(4)}$	$a_{46}^{(3)}$ … $b_{46}^{(4)}$	A_3
1	1	1	1	x_4 x_3 x_2 x_1	x_4 x_3 x_2 x_1	B

1-jadval

1-jadvalda keltirilgan Gaussning kompakt sxemasi yordamida quyidagi tenglamalar sistemasi yechilsin:

2-misol.

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

Sistemani yechish jarayoni 2-jadvalda keltirilgan.

2 - jadval

x_1	x_2	x_3	x_4	OZOD HADLAR	$\sum$	SXEMA QISMLARI
2 -0,4 1,6 1 … 1	4,2 3 -0,8 -2 … 2,1	1,6 -2,4 1 -1 … 0,8	-3 0 -1 1,5 … -1,5	3,2 -1,6 -1 0 … 1,6	8 -1,4 -0,2 -0,5 … 4	A
	3,84 4,16	-2,08 0,28	-0,60 -1,40	-0,96 3,56	0,2 6,6	A_1

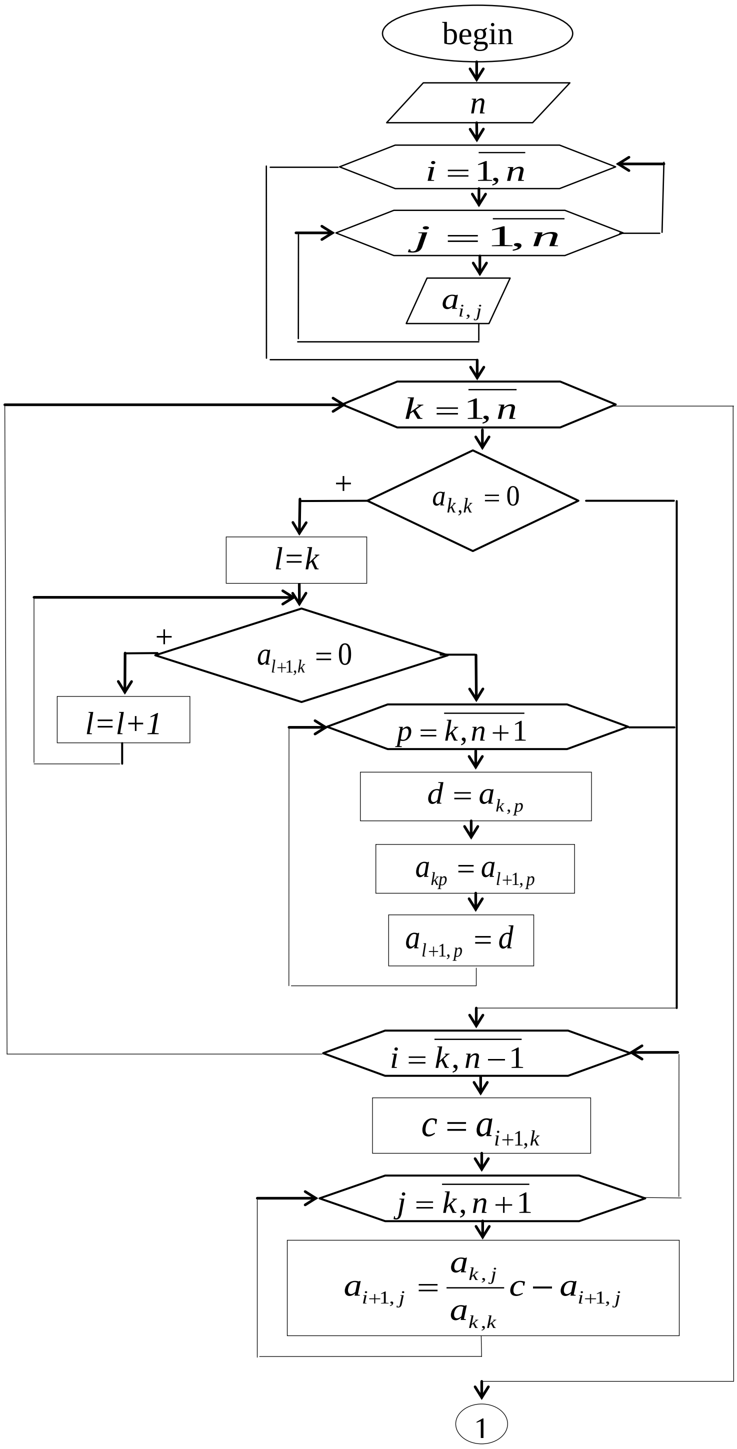
	4,1 … *1*	*1,8* … *-0,54166*	*-3* … *-0,15625*	*1,6* … *-0,25*	*4,5* … *0,05208*	
		-2,53331 *-4,02081* … *1*	*0,75* *2,35937* … *-0,29606*	*-4,6* *-2,62500* … *1,81581*	*-6,38331* *-4,28644* … *2,51198*	A_2
			1,16897	*4,67603*	*5,84500*	A_3
1	*1*	*1*	*1*	*4,00013* *3,00009* *2,00005* *1,00002*	*5,00013* *4,00009* *3,00005* *2,00002*	*B*

Shunday qilib, quyidagi x_1=1,00002 , x_2=2,00005 , x_3=3,00009 , x_4=4,00013 taqribiy yechimga ega bo‘ldik. Sistemaning aniq yechimi x_1=1, x_2=2, x_3=3, x_4=4 ekanligiga bevosita ishonch hosil qilish mumkin.

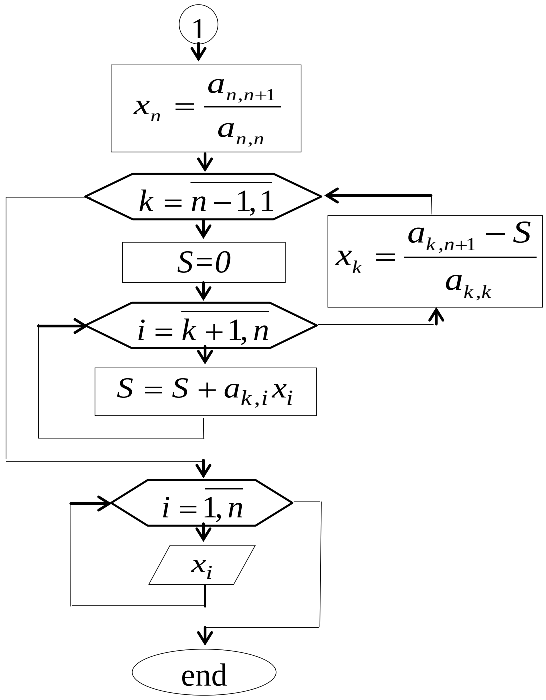
Misol. Quyidagi ko‘rinishdagi chiziqli algebraik tenglamalar sistemasini Gauss usuli yordamida yechish algoritmi va dasturini tuzing.

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = a_{1n+1} \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n = a_{2n+1} \\ \ldots\ldots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n = a_{nn+1} \end{cases}$$

Algoritmi:



begin
n
i = 1,n
j = 1,n
a_{i,j}
k = 1,n
+
a_{k,k} = 0
l=k
+
a_{l+1,k} = 0
l=l+1
p = k,n+1
d = a_{k,p}
a_{kp} = a_{l+1,p}
a_{l+1,p} = d
i = k,n−1
c = a_{i+1,k}
j = k,n+1
a_{i+1,j} = (a_{k,j} / a_{k,k}) c − a_{i+1,j}
1


1
$x_n = \frac{a_{n,n+1}}{a_{n,n}}$
$k = \overline{n-1, 1}$
$S=0$
$x_k = \frac{a_{k,n+1} - S}{a_{k,k}}$
$i = \overline{k+1, n}$
$S = S + a_{k,i} x_i$
$i = \overline{1, n}$
x_i
end

Dasturi:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n = b_2 \\ \ldots\ldots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n = b_n \end{cases}$$

```
Program Gauss1;
label 1,2,3,4,5;
var a:array[1..10, 1..10] of real;
   b,x:array[1..10] of real;
   c,s:real; i,j,k,n:integer;
   begin
      readln(n);
      for i:=1 to n do
        begin
          for j:=1 to n do
            read(a[i,j]);
          readln(b[i]);
        end;
      k:=1;
   3: i:=k+1;
   2: c:=a[i,k]/a[k,k];
      a[i,k]:=0;
      j:=k+1;
   1: a[i,j]:=a[i,j]-c*a[k,j];
      if j<n then begin j:=j+1; goto 1 end;
      b[i]:=b[i]-c*b[k];
      if i<n then begin i:=i+1; goto 2 end;
      if k<n-1 then begin  k:=k+1; goto 3 end;
      x[n]:=b[n]/a[n,n];
      i:=n-1;
   5: j:=i+1;
      s:=0;
   4: s:=s+a[i,j]*x[j];
      if j<n then begin  j:=j+1; goto 4 end;
      x[i]:=(b[i]-s)/a[i,i];
      if i>1 then begin i:=i-1; goto 5 end;
      for i:=1 to n do
        writeln(x[i]:4:2);
   end.
```

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = a_{1n+1} \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n = a_{2n+1} \\ \ldots\ldots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n = a_{nn+1} \end{cases}$$

```
program Gauss;
var a:array[1..10, 1..10] of real;
   x:array[1..10] of real;
   c,s,d:real; i,j,k,n,l,p:integer;
   begin
      readln(n);
      for i:=1 to n do
      for j:=1 to n+1 do
         readln(a[i,j]);
      for k:=1 to n do
      begin
      l:=k;
      while a[k,k]=0 do
        begin
          if a[l+1,k]=0 then else
            begin
              for p:=k to n+1 do7
                begin
                  d:=a[k,p];
                  a[k,p]:=a[l+1,p];
                  a[l+1,p]:=d;
                end;
              break;
            end;
          l:=l+1;
        end;
      for i:=k to n-1 do
        begin
          c:=a[i+1,k];
          for j:=k to n+1 do
             a[i+1,j]:=(a[k,j]/a[k,k])*c-a[i+1,j];
        end;
      end;
      x[n]:=a[n,n+1]/a[n,n];
      for k:=n-1 downto 1 do
      begin
         s:=0;
         for i:=k+1 to n do
         s:=s+a[k,i]*x[i];
         x[k]:=(a[k,n+1]-s)/a[k,k]
      end;
      for i:=1 to n do
        writeln(x[i]:4:2);
   end.
```

2-masala. Quyidagi chiziqli tenglamalar sistemasini yeching:

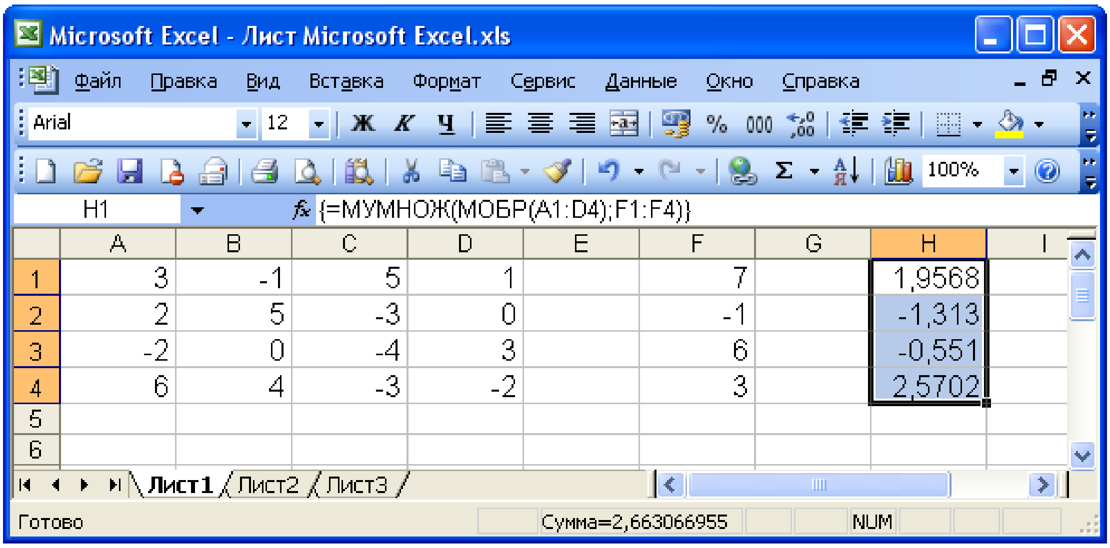
$$\begin{cases} 3x_1 - x_2 + 5x_3 + x_4 = 7 \\ 2x_1 + 5x_2 - 3x_3 = -1 \\ -2x_1 - 4x_3 + 3x_4 = 6 \\ 6x_1 + 4x_2 - 3x_3 - 2x_4 = 3 \end{cases}$$

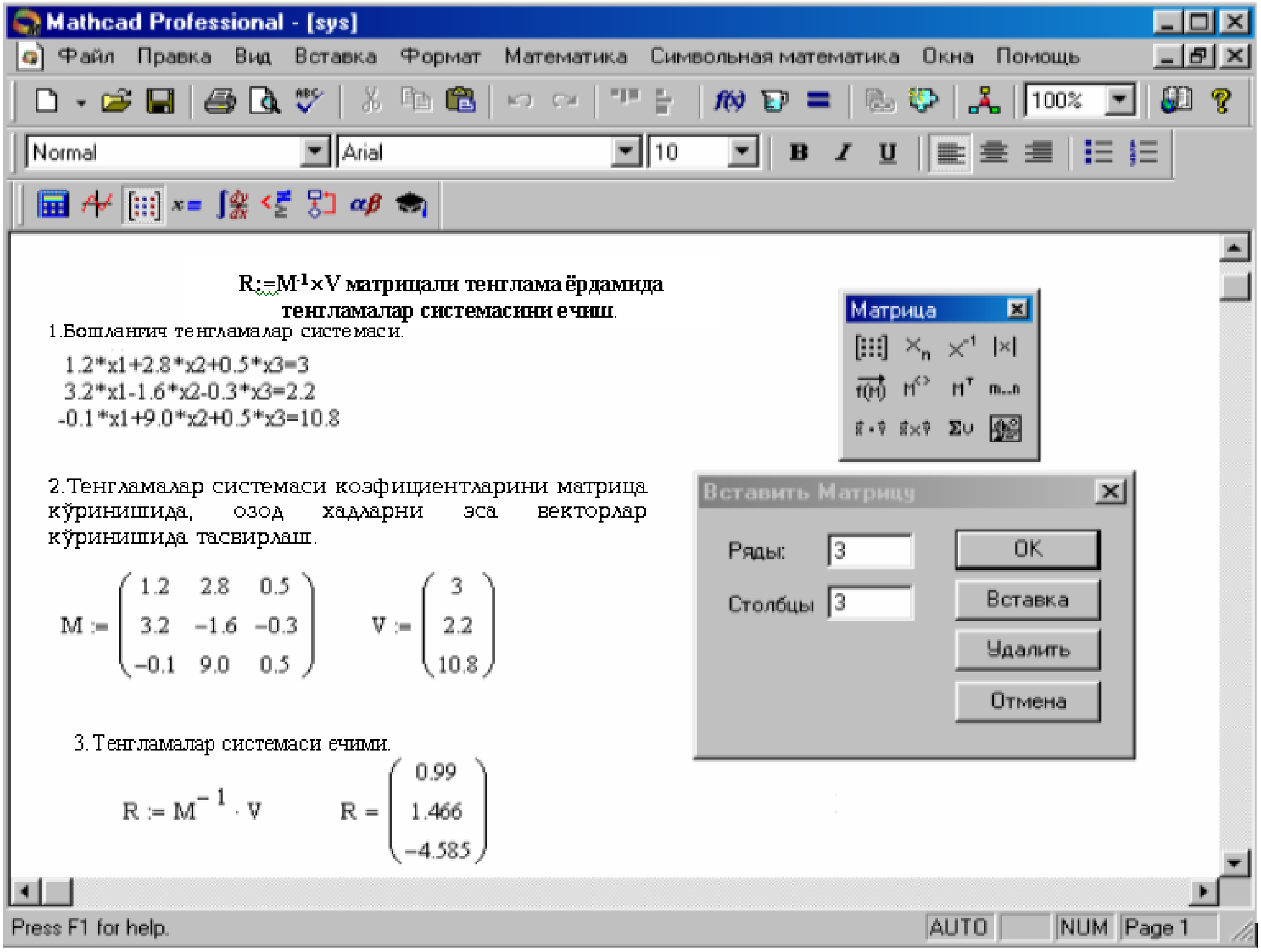
Bajarish. 1-masaladagidek, tenglamalar sistemasini $AX = B$ ko\`rinishda yozib olamiz. Bu yerda ***A*** – noma\`lumlar koeffisentlardan tashkil topgan matritsa, ***B***– ozod hadlardan tashkil topgan ustun (vektor), ***X***– noma\`lumlar ustuni (vektori).

$$A = \begin{pmatrix} 3 & -1 & 5 & 1 \\ 2 & 5 & -3 & 0 \\ -2 & 0 & -4 & 3 \\ 6 & 4 & -3 & -2 \end{pmatrix}, \quad B = \begin{pmatrix} 7 \\ -1 \end{pmatrix}, \quad X = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

Demak, $X = A^{-1}B$.

A matritsani, ya\`ni noma\`lumlar koeffisentlarini **A1:D4** maydonga, ***B*** vektorni, ya\`ni ozod hadlarni **F1:F4** maydonga kiritamiz. ***X*** vektor uchun **H1:H4** maydonni belgilab **=МУМНОЖ(МОБР(A1:D4);F1:F4)** formulani kiritamiz va **Ctrl+Shift+Enter** tugmalarini birgalikda bosamiz. Natijada **H1:H4** maydonda izlanayotgan noma\`lumlar hosil bo\`ladi:




Mathcad Professional - [sys]
Файл Правка Вид Вставка Формат Математика Символьная математика Окна Помощь
Normal
Arial
10
100%
R:=M-1×V матрицали тенглама ёрдамида тенгламалар системасини ечиш.
1.Бошлангич тенгламалар системаси.
1.2*x1+2.8*x2+0.5*x3=3
3.2*x1-1.6*x2-0.3*x3=2.2
-0.1*x1+9.0*x2+0.5*x3=10.8
2.Тенгламалар системаси коэфициентларини матрица кўринишида, озод хадларни эса векторлар кўринишида тасвирлаш.
M := (1.2 2.8 0.5; 3.2 −1.6 −0.3; −0.1 9.0 0.5)
V := (3; 2.2; 10.8)
3.Тенгламалар системаси ечими.
R := M−1 · V
R = (0.99; 1.466; −4.585)
Матрица
Вставить Матрицу
Ряды: 3
Столбцы 3
OK
Вставка
Удалить
Отмена
Press F1 for help.
AUTO
NUM
Page 1

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