

**O'ZBEKISTON RESPUBLIKASI OLIY VA O'RTA MAHSUS TALIM
VAZIRLIGI
TOSHKENT KIMYO-TEHNOLOGIYALARI INSTITUTI**

HISOBLASH USULLARINI ALGORITMLASH

fanidan

laboratoriya vazifalarini bajarish uchun uclubiy ko'rsatma

Uclubiy ko'rsatma bakalavriaturaning "Tehnologik jarayonlar va ishlab
chiq'arishni avtomatlashtirish" ta'lim yo'nalishi talabalari uchun mo'ljallangan

Toshkent - 2014

Mazkur uclubiy ko'rsatmada, "Hicoblash ucullarini algoritmlash" o'q'uv kursida berilgan bilimlarni mustahkamlash maqsadida laboratoriya mashg'ulotlarida bajariladigan vazifalar berilgan bo'lib, vazifalarni bajarish uchun uslubiy ko'rsatmalar, algoritmlar va Delphi dasturlash tizimida ishlatishga mo'ljallangan dastur kodlari keltirilgan. Uslubiy ko'rsatmada hatoliklar nazariyasidan, chiziq'li va chiziq'siz algebraik tenglamalarning echimlarini taq'ribiy usullar bilan topish, oddiy differentsial tenglamalar echimlarini taq'ribiy usullar bilan topish, aniq' integrallarni taq'ribiy usullar bilan hisoblash va tajriba natijalariga ishlov berishga doir misollar keltirilgan.

Uslubiy ko'rsatma "Tehnologik jarayonlar va ishlab chiq'arishni avtomatlashtirish" ta'lim yo'nalishi hamda yaq'in mutahassisliklar bo'yicha ta'lim oladigan bakalavriatura talabalari uchun mo'ljallangan.

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Uslubiy ko'rsatma "Informatika, avtomatlashtirish va boshq'aruv" kafedrasida majlisida ko'rib chiq'ilgan.

Bayonnoma № _____

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Uslubiy ko'rsatma "Oziq'-ovq'at mahsulotlari texnologiyalari" fakultetining kengaytirilgan ilmiy-uslubiy kengashida ko'rib chiq'ilgan. Bayonnoma № _____

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Uslubiy ko'rsatma TKTI ilmiy-uslubiy kengashida ko'rib chiq'ilgan, chop etishga va ahborot resurslar markaziga topshirishga tavsiya etilgan. Bayonnoma № _____

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Laboratoriya ishi № 1
Hatoliklar nazariyasi va ko'phad q'iymatini hisoblash.

1-Vazifa. Formula buyicha hisoblab olingan natija hatoliklarini toping.

Laboratoriya ishiga doir topshiriq' variantlari:

№ 1. 1) $X = \frac{ab}{\sqrt[3]{c}}$

	a	b	V
a	3,85 (±0,01)	4,16 (±0,005)	7,27 (±0,01)
b	2,0435 (±0,0004)	12,163 (±0,002)	5,205 (±0,002)
c	962,6 (±0,1)	55,18 (±0,01)	87,32 (±0,03)

2) $X = \left[\frac{(a+b)^2}{m-n} \right]^2$

	a	b	v
a	4,3 (±0,05)	5,2 (±0,04)	2,13 (±0,01)
b	17,21 (±0,02)	15,32 (±0,01)	22,16 (±0,03)
m	12,417 (±0,003)	21,823 (±0,002)	16,825 (±0,004)
n	8,37 (±0,005)	7,56 (±0,003)	8,13 (±0,002)

3) $S = \frac{h^2}{18} \div \frac{a^2 + 4ab + b^2}{(a+b)^2}$

	a	B	v
a	1,141	2,234	5,813
b	3,156	4,518	1,315
h	1,14	4,48	2,56

№2. 1) $X = \frac{\sqrt{a} \cdot b}{c}$

	a	B	v
a	228,6 (±0,06)	315,6 (±0,05)	186,7 (±0,04)
b	86,4 (±0,02)	72,5 (±0,03)	66,6 (±0,02)
c	68,7 (±0,05)	53,8 (±0,04)	72,3 (±0,03)

2) $X = \frac{m^3 (a+b)}{c-d}$

	A	B	v

a	13,5 (±0,02)	18,5 (±0,03)	11,8 (±0,02)
b	3,7 (±0,02)	3) 5,6 (±0,02)	7,4 (±0,03)
m	4,22 (±0,004)	4) 3,42 (±0,003)	5,82 (±0,005)
c	34,5 (±0,02)	5) 26,3 (±0,01)	26,7 (±0,03)
d	23,725 (±0,005)	6) 14,782 (±0,006)	11,234 (±0,004)

$$3) M = (a+b)h^3 / 4 + (a+b)h/12$$

	A	B	v
a	8,53	6,44	9,05
b	6,271	5,323	3,244
h	12,48	15,44	20,18

$$\text{№3. 1) } X = \frac{\sqrt{ab}}{c}$$

	a	B	v
a	3,845 (±0,004)	4,632 (±0,003)	7,312 (±0,004)
b	16,2 (±0,05)	23,3 (±0,04)	18,4 (±0,03)
c	10,8 (±0,1)	11,3 (±0,06)	20,2 (±0,08)

$$2) X = \frac{(a+b)m}{(c-d)^2}$$

	a	B	v
a	2,754 (±0,001)	3,236 (±0,002)	4,523 (±0,003)
b	11,7 (±0,04)	15,8 (±0,03)	10,8 (±0,02)
m	0,56 (±0,005)	0,64 (±0,004)	0,85 (±0,003)
c	10,536 (±0,002)	12,415 (±0,003)	9,318 (±0,002)
d	6,32 (±0,008)	7,18 (±0,006)	4,17 (±0,004)

$$3) N = \frac{(a+b)^2}{2h} + \frac{(a^2+b^2)h}{5}$$

	a	B	v
a	0,562	0,834	0,445
b	0,2518	0,3523	0,4834
h	0,68	0,74	0,87

$$\text{№4. 1) } X = \frac{a^2 b}{c}$$

	A	B	v
a	3,456 ($\pm 0,002$)	1,245 ($\pm 0,001$)	0,327 ($\pm 0,005$)
b	0,642 ($\pm 0,0005$)	0,121 ($\pm 0,0002$)	3,147 ($\pm 0,0001$)
c	7,12 ($\pm 0,004$)	2,34 ($\pm 0,003$)	1,78 ($\pm 0,001$)

$$2) X = \frac{(a+b)m}{\sqrt{c-d}}$$

	A	B	v
a	23,16 ($\pm 0,02$)	17,41 ($\pm 0,01$)	32,37 ($\pm 0,03$)
b	8,23 ($\pm 0,005$)	1,27 ($\pm 0,002$)	2,35 ($\pm 0,001$)
c	145,5 ($\pm 0,08$)	342,3 ($\pm 0,04$)	128,7 ($\pm 0,02$)
d	28,6 ($\pm 0,1$)	11,7 ($\pm 0,1$)	27,3 ($\pm 0,04$)
m	0,28 ($\pm 0,006$)	0,7 ($\pm 0,003$)	0,93 ($\pm 0,001$)

$$3) V = \frac{h}{3} \cdot S \left(1 + \frac{a}{A} + \frac{a^2}{A^2} \right)$$

	A	B	v
a	8,51	5,71	7,28
A	23,42	32,17	11,71
S	45,8	51,7	21,8
h	3,81	2,42	5,31

$$\text{№5. 1) } X = \frac{ab^2}{c}$$

	A	b	v
a	0,643 ($\pm 0,0005$)	0,142 ($\pm 0,0003$)	0,258 ($\pm 0,0002$)
b	2,17 ($\pm 0,002$)	1,72 ($\pm 0,002$)	3,45 ($\pm 0,001$)
c	5,843 ($\pm 0,001$)	3,1727 ($\pm 0,001$)	7,221 ($\pm 0,003$)

$$X = \frac{(a-b)c}{\sqrt{m+n}}$$

$$2) X = (a-b)c / \sqrt{m+n}$$

	A	b	v
a	27,16 ($\pm 0,006$)	15,71 ($\pm 0,005$)	12,31 ($\pm 0,004$)
b	5,03 ($\pm 0,01$)	3,28 ($\pm 0,02$)	1,73 ($\pm 0,03$)
c	3,6 ($\pm 0,02$)	7,2 ($\pm 0,01$)	3,7 ($\pm 0,02$)
m	12,375 ($\pm 0,004$)	13,752 ($\pm 0,001$)	17,428 ($\pm 0,003$)
n	86,2 ($\pm 0,05$)	33,7 ($\pm 0,03$)	41,7 ($\pm 0,01$)

$$3) S = \frac{h^2}{18} \cdot \frac{a^2 + 4ab + b^2}{(a+b)^2}$$

	A	b	v
h	21,1	17,8	32,5
a	22,08	32,47	27,51
b	31,11	11,42	21,78

$$\text{№6. 1) } X = \frac{ab}{c^2}$$

	A	b	v
a	0,3575(±0,0002)	0,1756 (±0,0001)	0,2731 (±0,0003)
b	2,63 (±0,01)	3,71 (±0,03)	5,12 (±0,02)
c	0,854 (±0,0005)	0,285 (±0,0002)	0,374 (±0,0001)

$$2) X = \frac{a+b}{\sqrt{(c-a)m}}$$

	a	b	v
a	16,342 (±0,001)	12,751 (±0,001)	31,456 (±0,002)
b	2,5 (±0,03)	3,7 (±0,02)	7,3 (±0,01)
c	38,17 (±0,002)	23,76 (±0,003)	33,28 (±0,003)
d	9,14 (±0,005)	8,12 (±0,004)	6,71 (±0,001)
m	3,6 (±0,04)	1,7 (±0,01)	5,8 (±0,02)

$$3) V = \frac{1}{6} \pi h (3a^2 + h^2)$$

	a	b	v
a	2,456	7,751	5,441
h	1,76	3,35	6,17

$$\text{№ 7 1) } v = D \frac{d^2}{4} \pi^2$$

	a	B	V
π	3.14	3.14	3.14
D	54(± 0.5)	72(± 0.3)	31(± 0.01)
D	8.235(± 0.001)	3.274(± 0.002)	7.345(± 0.001)

$$2) S = \sqrt{D^* - d^*} * \pi / 64$$

	a	B	V
D	36.5(± 0.1)	41.4(± 0.2)	52.6(± 0.01)
d	26.35(± 0.005)	31.75(± 0.003)	48.39(± 0.001)
π	3.14	3.14	3.14

$$3) a = c^2 \left(1 + \frac{2\beta}{c} + \frac{\gamma^2}{c^2} \right)$$

	A	b	V
c	2.435	7.834	4.539
β	0.15	0.21	0.34
γ	1.27	3.71	5.93

№ 8 1) $Y = \frac{m^2 n}{c^3}$

	A	b	V
m	1.6531	2.348(± 0.002)	3.804(± 0.003)
n	(± 0.0003)	4.37(± 0.004)	4.05(± 0.003)
c	3.78(± 0.002)	0.235(± 0.0003)	0.318(± 0.0002)
	0.158(± 0.0005)		

$$2) X = \frac{\sqrt[m]{a - b}}{c + d}$$

	a	b	V
a	9.542(± 0.001)	8.357(± 0.003)	4.218(± 0.001)
b	3.128(± 0.002)	2.48(± 0.004)	1.57(± 0.006)
m	2.8(± 0.03)	3.17(± 0.01)	2.32(± 0.02)
c	0.172(± 0.001)	1.315(± 0.0004)	2.418(± 0.004)
d	5.4(± 0.02)	2.4(± 0.02)	1.8(± 0.01)

$$3) V = 1/15\pi h (2D^2 + Dd + d^2 \cdot 0.75)$$

	a	b	V
h	84.2	76	45
D	28.3	17.2	48.3
d	42.08	9.344	32.14

$$\text{№ 9 } 1) X = \sqrt{\frac{cd}{b}}$$

	A	b	V
C	0.7568	0.8345	0.6384(± 0.0002)
d	(± 0.0002)	(± 0.0004)	32.7(± 0.04)
b	21.7(± 0.02)	13.8(± 0.03)	4.88(± 0.03)
	2.65(± 0.01)	1.84(± 0.006)	

$$2) y = \frac{\sqrt[3]{a-b}}{m(n-a)}$$

	A	b	V
a	10.82(± 0.03)	9.37(± 0.004)	11.45(± 0.01)
b	2.786(± 0.0006)	3.108	4.431(± 0.002)
m	0.28(± 0.006)	(± 0.0003)	0.75(± 0.003)
n	14.7(± 0.06)	0.46(± 0.002)	16.7(± 0.05)
		15.2(± 0.04)	

$$3) S = \sqrt{p(p-a)(p-b)(p-c)}, \text{ gde } p = (a+b+c)/2$$

	a	b	V
a	46.3	10.5	2.48
b	29.72	34.18	5.344
c	37.654	27.327	6.0218

№ 10 1) $f = \frac{Qe^a}{48E}$

	a	b	V
Q	54.8(± 0.02)	38.5(± 0.01)	17.3(± 0.03)
e	2.45(± 0.01)	3.35(± 0.02)	5.73(± 0.01)
E	0.863(± 0.004)	0.734(± 0.001)	0.956(± 0.004)

2) $Q = (2n-1)^2(x+y) / (x-y)$

	A	b	V
n	2.0435(± 0.0001)	1.1753(± 0.0002)	4.5681(± 0.0001)
x	4.2(± 0.05)	5.8(± 0.01)	6.3(± 0.02)
y	0.82(± 0.01)	0.65(± 0.02)	0.42(± 0.03)

3) $\gamma = (\alpha b - \beta a) / b^2 - \beta(ab - \beta a) / b^2 (b + \beta)$

	A	b	V
α	5.27	7.31	3.28
β	0.0562	0.0761	0.0545
a	158.35	234.36	341.17
b	61.21	81.26	52.34

Vazifani bajarish namunasi

- 1) $X = \frac{m^2 n^3}{\sqrt{k}}$, bunda $m = 28.3 (\pm 0.02)$, $n = 7.45 (\pm 0.01)$, $k = 0.678 (\pm 0.003)$;
- 2) $N = \frac{(n-1)(m+n)}{(m-n)^2}$, bunda $n = 3.0567 (\pm 0.0001)$, $m = 5.72 (\pm 0.02)$;
- 3) $V = \pi h^2 \left(R - \frac{h}{3} \right)$, bunda $h = 11.8$, $R = 23.67$.

1) Hisoblaymiz $m^2 = 800.9$; $n^3 = 413.5$; $\sqrt{k} = 0.8234$;

$$X = \frac{800.9 * 413.5}{0.8234} = 402200 = 4.02 * 10^5$$

$$\text{Sungra, } \delta_m = \frac{0.02}{28.3} = 0.00071; \text{ hisoblab}$$

$$\delta_n = \frac{0.01}{7.45} = 0.00135; \delta_k = \frac{0.003}{0.678} = 0.00443, \text{ bundan}$$

$$\delta_x = 2\delta_m + 3\delta_n + 0.5\delta_k = 0.00142 + 0.00405 + 0.00222$$

$$= 0.00769 = 0.77\%$$

$$\alpha_x = 4.02 * 10^5 * 0.0077 = 3.1 * 10^3$$

$$\text{Javob: } X = 4.02 * 10^5 (\pm 3.1 * 10^3); \delta_x = 0.77\%$$

2) Berilgan : $n-1 = 2.0567 (\pm 0.0001)$; $m+n = 3.057 (\pm 0.0004) +$
 $5.72 (\pm 0.02) = 8.777 (\pm 0.00204)$; $m-n = 5.72 (\pm 0.02) -$
 $3.057 (\pm 0.0004) = 2.663 (\pm 0.0204)$;

$$N = \frac{2.0567 * 8.777}{2.663^2} = \frac{2.0567 * 8.777}{7.092} = 2.545 \approx 2.55;$$

$$\delta_n = 0.00238 + 0.01532 = 0.0177 = 1.77\%;$$

$$\alpha_N = 2.55 * 0.0177 = 0.046$$

$$\text{Otvet: } N; \delta_n = 1.77\%$$

3) Hisoblaymiz:

$$V = 3.142 * 11.8^2 (23.67 - 3.933) = 3.142 * 11.8^2 * 19.737 =$$

$$8.63 * 10^3 = 3.142 * 139.2 * 19.737 = 437.37 * 19.737 = 8630$$

$$\text{Javob: } V \approx 8.63 * 10^3$$

2-Vazifa. Kuphadlarni Gornier shemasidan foydalanib hisoblang.

Gornier shemasidan foydalanib kuidagilarni bajaring:

1. $H = 0,2$. uchun berilgan kuphad qiymatini hisoblang.
2. $[0,5; 2,0]$. oralikda $0,25$ ga teng kadam bilan kuphad qiymatini hisoblang.

Laboratoriya ishiga doir topshiriq' variantlari:

№1	$1,723H^5 + 0,137H^4 - 0,814H^3 + 2,364H^2 - 1,176H + 3,962$
№2	$1,654H^5 + 0,213H^4 - 0,744H^3 + 1,283H^2 - 2,151H + 4,134$
№3	$1,514H^5 - 0,124H^4 - 0,548H^3 + 3,214H^2 - 1,124H + 2,258$
№4	$0,372H^5 - 0,612H^4 + 0,532H^3 + 1,134H^2 - 1,247H - 1,624$
№5	$0,853H^5 - 1,514H^4 - 0,143H^3 + 1,217H^2 - 2,243H + 2,415$
№6	$0,623H^5 + 1,275H^4 - 0,217H^3 + 1,315H^2 - 3,174H - 1,862$
№7	$1,273H^5 + 0,116H^4 - 0,343H^3 + 3,115H^2 - 1,262H + 0,375$
№8	$0,375H^5 - 1,213H^4 + 1,108H^3 + 0,742H^2 - 3,115H + 2,724$
№9	$1,116H^5 + 0,127H^4 - 0,316H^3 + 1,164H^2 - 2,273H - 1,123$

№10	$0,764H^5 - 0,312H^4 + 1,216H^3 - 2,458H^2 - 1,273H + 0,834$
№11	$0,374H^5 + 0,242H^4 - 1,413H^3 + 0,746H^2 + 3,183H - 0,678$
№12	$1,073H^5 - 0,143H^4 + 0,568H^3 + 1,215H^2 - 3,146H + 1,618$
№13	$0,513H^5 - 0,837H^4 + 1,215H^3 + 2,453H^2 - 1,783H - 0,847$
№14	$1,087H^5 - 1,243H^4 + 0,656H^3 - 0,783H^2 + 2,574H + 0,564$
№15	$0,683H^5 + 1,143H^4 - 0,562H^3 + 1,844H^2 - 2,154H + 1,472$
№16	$1,213H^5 - 0,216H^4 + 1,316H^3 - 2,758H^2 + 3,612H - 0,388$
№17	$1,316H^5 - 0,144H^4 - 0,572H^3 + 1,854H^2 - 2,713H + 1,625$
№18	$1,172H^5 - 0,534H^4 - 0,316H^3 + 1,283H^2 + 1,615H - 2,652$
№19	$0,613H^5 + 0,318H^4 - 1,216H^3 + 2,517H^2 - 3,712H + 0,454$
№20	$0,278H^5 - 0,763H^4 + 1,072H^3 + 1,613H^2 - 2,312H - 1,418$
№21	$0,475H^5 - 0,612H^4 + 1,314H^3 + 1,183H^2 - 3,154H + 0,844$
№22	$0,683H^5 + 0,514H^4 - 0,817H^3 + 2,423H^2 + 1,072H - 0,833$
№23	$1,028H^5 - 0,713H^4 - 1,072H^3 + 1,625H^2 - 3,184H - 1,546$
№24	$0,243H^5 - 1,065H^4 - 0,364H^3 + 2,445H^2 - 1,265H + 0,318$
№25	$0,831H^5 - 0,722H^4 + 1,157H^3 + 1,615H^2 - 2,844H - 0,685$
№26	$0,354H^5 + 0,583H^4 - 1,072H^3 + 1,548H^2 - 2,436H - 0,367$
№27	$1,273H^5 + 0,172H^4 - 0,788H^3 + 1,453H^2 - 2,813H + 3,154$
№28	$0,421H^5 - 0,544H^4 - 1,213H^3 + 0,683H^2 + 3,145H - 0,185$
№29	$1,342H^5 - 0,254H^4 + 0,872H^3 + 1,273H^2 - 1,483H + 0,584$
№30	$1,418H^5 - 1,547H^4 + 0,418H^3 + 1,783H^2 - 2,517H + 2,434$

Vazifani bajarish uchun kursatma:

$\alpha(0), \dots, \alpha(n)$ ko'effitsientlarga ega n – darajali ko'phad berilgan bo'lsin. Bu ko'phadni Gorner shemasiga binoan berilgan nuq'tada hisoblash q'uyidagicha bajariladi. Polinomni R desak, unda R polinom Gorner shemasi bo'yicha $S=(\dots((\alpha(0)*h+ \alpha(1))*h+ \alpha(2))*h+\dots)*h+ \alpha(n)$ ko'rinishga keltiriladi. Demak hisoblash jarayoni $P:= \alpha(i)$ ni kerakli marotaba H ga ko'paytirishdan va $\alpha(i)$ ni q'o'shishdan iborat bo'ladi.

Gorner shemasi bo'yicha hisoblash algoritmi:

Polinom qiymatini hisoblash uchun quyidagi Gorner shemasidan foydalanish kulaydir:

	α_0	α_1	α_2	α_3	α_4	α_{n-1}	α_n
Ξ		$b_0\xi$	$b_1\xi$	$b_2\xi$	$b_3\xi$	$b_{n-2}\xi$	$b_{n-1}\xi$
	b_0	b_1	b_2	b_3	b_4	b_{n-1}	b_n

Bunda $b_0 = \alpha_0$, $b_1 = b_0\xi + \alpha_1$, $b_2 = b_1\xi + \alpha_2$, $b_3 = b_2\xi + \alpha_3$, $b_4 = b_3\xi + \alpha_4$,

- | | |
|--------------------------|---------------------------|
| 7. a) $2x^3+2x-4=0$ | b) $2x-\lg x=3$ |
| 8. a) $x^3-2x^2+7x-1=0$ | b) $x = \sqrt{\lg(x+2)}$ |
| 9. a) $2x^3+3x+4=0$ | b) $x^2=3\sin x$ |
| 10. a) $x^3-3x^2+6x+2=0$ | b) $3x-2\ln x=4$ |
| 11. a) $x^3-2x+2=0$ | b) $4x-e^x=0$ |
| 12. a) $x^3-3x^2+2x-4=0$ | b) $x \cdot (x+1)^2=2$ |
| 13. a) $x^3+x-8=0$ | b) $3-2x=\ln x$ |
| 14. a) $x^3-3x^2+5x+1=0$ | b) $2x-\cos x=0$ |
| 15. a) $x^3-x+2=0$ | b) $\sin(x/2)+1=x^2$ |
| 16. a) $x^3-3x^2+7x+1=0$ | b) $2x+\lg x=-0,5$ |
| 17. a) $x^3-3x+1=0$ | b) $(2-x) \cdot e^x=1$ |
| 18. a) $x^3+x^2+2x+4=0$ | b) $x^3=2\sin x$ |
| 19. a) $x^3-2x-5=0$ | b) $2x-2^x=0$ |
| 20. a) $x^3+2x^2+3x-2=0$ | b) $x^2-4 \cdot \sin x=0$ |
| 21. a) $x^3+4x-6=0$ | b) $x^2=\ln(x+2)$ |
| 22. a) $x^3-3x^2+6x-5=0$ | b) $2x-\cos x=0$ |
| 23. a) $x^3-2x+7=0$ | b) $3x+\cos x=2$ |
| 24. a) $x^3-4x+1=0$ | b) $x+\lg x=1,5$ |
| 25. a) $x^3+2x+1=0$ | b) $x\sqrt{x+2}-3=0$ |

1- vazifani bajarish uchun ko'rsatma:

a) Analitik usul. Kuyidagi dastur kodidan foydalanib tenglama argumenti H ga kiymatlar bering, funktsiya Y ni hisoblang va jadvalni tuldiring.

Program Oraliq; Const k=3;

```

Var I : integer ; Y : Real;
Begin For i:=0 to 2*k do begin
  Y:= { tenglamani ung tomonidagi H urniga -k + i yozing}
  Writeln ('Y=', Y) end;
End.

```

H	-3	-2	-1	0	1	2	3
Y							

Jadvalda Y kiymatlarining ishoralari uzgarishiga karab echimlar joylashgan [a; b] oralikni aniklang.

b) Grafik usul. Berilgan tenglamani ikki kismga, f1 va f2 ga ajrating, bunda f1 = f2. YUkorida keltirilgan dastur kodi bilan hisoblab topilgan Y1=f1 va Y2=f2 funktsiyalar kiymatlarini jadvallarga kiriting.

H	-3	-2	-1	0	1	2	3
Y1							

H	-3	-2	-1	0	1	2	3
Y2							

Y1=f1 va Y2=f2 funktsiyalar grafiklarini chizing va kesishish nuktalarini topib tenglama ildizlari joylashgan oralik [a; b] ni toping.

2- vazifani bajarish uchun kursatma:

Algebraik tenglamaning taq'ribiy echimini berilgan [a;b] oraliq'da topishni q'uyidagi algoritm bo'yicha tashkil q'ilamiz:

1. Berilgan [a;b] oraliq'ni o'rtasini hisoblaymiz.

$$c = \frac{a+b}{2}$$

2. Echimni [a;c] yoki [c;b] oraliq'daligini

$$f(a) \cdot f(c) < 0$$

shartidan foydalanib aniq'laymiz.

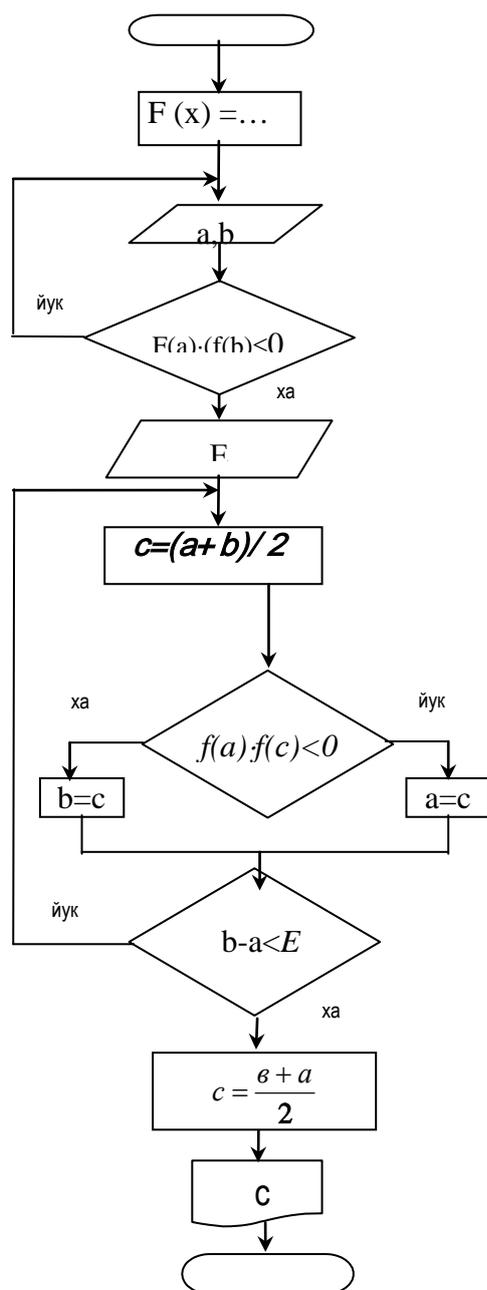
3. SHartni q'anoatlantiradigan oraliq'ni yangi oraliq' sifatida olamiz va uni teng ikkiga bo'lib, yuq'oridagi amallarni yana takrorlaymiz.

4. Odatda tenglamaning taq'ribiy echimini birorta aniq'lik bilan topish so'raladi. Demak δ aniq'lik berilgan bo'lsa, oraliq'ni bo'lish jarayonining har

bir q'adamida $|b-a| < \delta$ shart bajarilishi tekshiriladi. SHart bajarilganda oraliq'ninig o'rta nuq'tasi h^* , δ aniq'lik bilan topilgan taq'ribiy echim sifatida q'abul q'ilinadi.

YAngi oraliq' uchun yuq'oridagi ishlarni q'ayta takrorlaymiz va buni oraliq' uzunligi δ -dan kichik bo'lmaguncha davom ettiramiz. Ohirgi oraliq'ni urta nuq'tasini tenglamaning taq'ribiy echimi sifatida q'abul q'ilish mumkin.

Oralikni teng ikkiga bulish usulining algoritmi:



Oralikni teng ikkiga bulish usuli uchun dastur kodi:

```

program ikkiga_bolish;
var a,b,eps:real;
function f(x:real):real;
begin f:= { tenglamani o'ng tarafini yozing } end;
begin
write('a,b,eps=?');readln(a,b,eps);
1 : c:=(a+b)/2;
if f(a)*f(c)<0 then b:=c else a:=c;
if (b-a)> e then goto 1;
write(' Echim =', (a+b)/2)
end.

```

3 - vazifani bajarish uchun ko'rsatma:

Q'uyidagi shartlardan foydalanib, boshlangich qiymat sifatida **a** yoki **v** ni tanlab olish mumkin. $f(a)f(c) < 0$ bulsa $x_0 = \underline{a}$, $f(a)f(c) > 0$ bulsa $x_0 = \underline{v}$

Boshlangich qiymat aniqlangandan keyin shu nuktadan urinma utkaziladi.

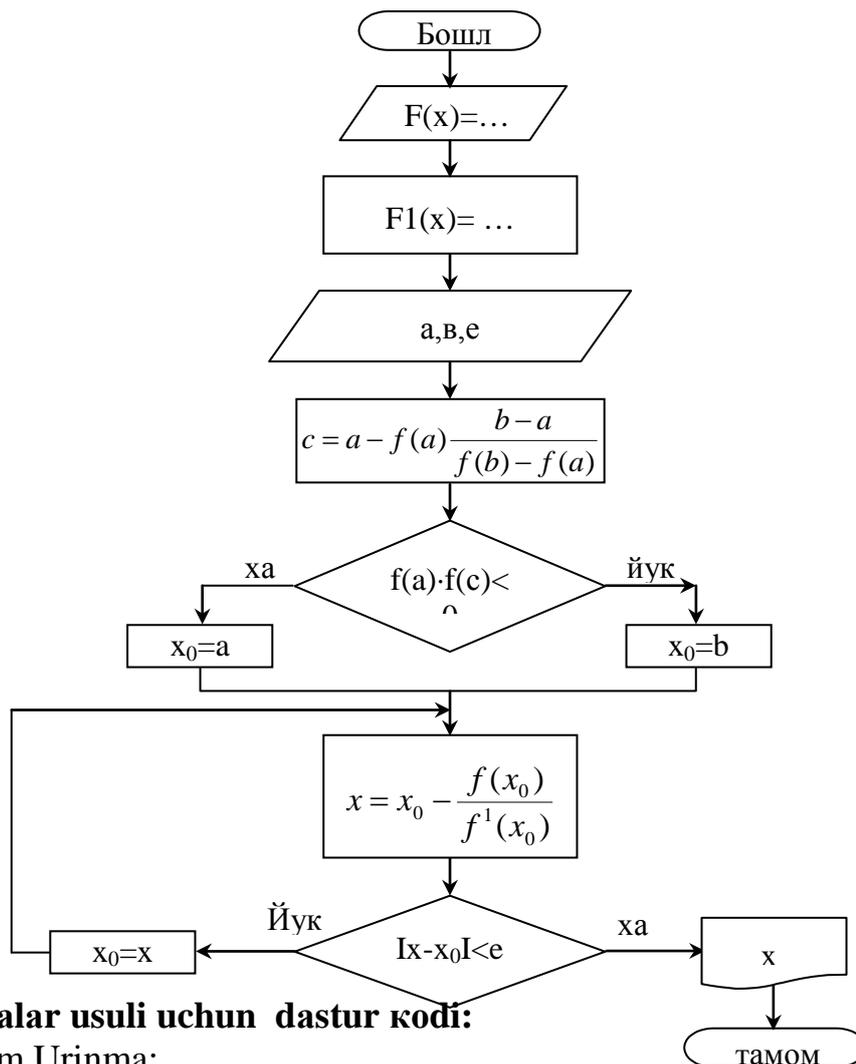
Urinmalar yordamida ketma-ket yaqinlashishlarni amalga oshiramiz. Uning ishchi

algoritmi biror nuktadan utuvchi urinmalar tenglamasi orkali aniqlanadi:

$$x_n = x_{n-1} - \frac{f(x_{n-1})}{f'(x_{n-1})}, \quad n = 1, 2, \dots$$

Hisoblashlar $|x_n - x_{n-1}| < E$ shart bajarilguncha davom ettiriladi. Bu erdagi h_0 – boshlangich qiymat.

Urinmalar usulining algoritmi:



Urinmalar usuli uchun dastur kodi:

Program Urinma;

Label 1,2,3,4;

Var a,b,x1, x2, eps : real;

Function F (x: real): real; Begin F: = ... end;

Function F 1(x: real): real; Begin F 1: = ... end;

Function F 2(x: real): real; Begin F 2: = ... end;

Begin

writeln('a,b='); readln(a,b);

writeln(' aniklikni kiriting'); readln(eps);

if F1(a)*F2(a)>0 then x1:=b else goto 2;

1: x2:=x1 - F(x1) / F1(x1);

If abs(x2-x1)>eps then begin x1:=x2;goto1 end else goto3 ;

2 : if F1(a)*F2(a)<0 then x1:=a;

4: x2:=x1 - F(x1) / F1(x1);

If abs(x2-x1)>eps then begin x1:=x2;goto 4 end ;

3 : Writeln ('tenglama echimi= ',x); End.

Vatarlar usuli uchun dastur kodi:

Program Vatar;

```

Label 1,2,3,4;
Var   a,b,x1, x2, eps : real;
      Function F (x: real): real; Begin F: = ... end;
      Function F 1(x: real): real; Begin F 1: = ... end;
      Function F 2(x: real): real; Begin F 2: = ... end;
Begin
  writeln('a,b='); readln(a,b);
writeln(' aniklikni kiriting'); readln( eps);
if F1(a)*F2(a)>0 then x1:=a else goto 2;
  1: x2:=x1 - F(x1)*(b-x1) / (F(b)-F(x1));
  If abs(x2-x1)>eps then begin x1:=x2;goto 1 end else goto 3 ;
2 : if F1(a)*F2(a)<0 then x1:=b;
  4: x2:=x1 - F(x1)*(x1-a) / (F(x1)-F(a));
  If abs(x2-x1)>eps then begin x1:=x2;goto 4 end ;
3 : Writeln ('tenglama echimi= ',x);
End.

```

Dastur kodida: F - tenglamani ung tomoni;
 F1 - tenglama ung tomonidan olingan birinchi hosila
 F2 - tenglama ung tomonidan olingan ikkinchi hosila
 a , b – oralikni chap va ung chegaralari.
 Eps – hisoblash anikligi.

Laboratoriya ishi №3 .

Chiziqli algebraik tenglamalar sistemasini Gauss va Kramer usullari bilan echimlarini topish.

Vazifa: Chiziqli algebraik tenglamalar sistemasini Gauss va Kramer usullari bilan echimlarini toping. Algoritmini tuzib, dasturlash tilida dastur kodini yozib natija oling.

Laboratoriya ishiga doir topshiriq' variantlari:

$$1. \left. \begin{aligned} 1,4x_1 + 0,3x_2 - 0,4x_3 + 0,9x_4 &= 1,3, \\ 0,6x_1 - 0,4x_2 + 1,3x_3 - 0,6x_4 &= -0,4, \\ 0,8x_1 - 2,2x_2 - 0,5x_3 + 0,5x_4 &= 0,6, \\ 0,3x_1 + 1,4x_2 + 0,6x_3 - 1,3x_4 &= 0,9. \end{aligned} \right\}$$

$$2. \left. \begin{aligned} 7,5x_1 - 2,4x_2 + 4,1x_3 + 1,2x_4 &= 9,9, \\ 7,1x_1 + 2,7x_2 - 1,4x_3 + 1,4x_4 &= 6,9, \\ -1,8x_1 - x_2 + 4,3x_3 + 1,3x_4 &= 7,9, \\ 1,5x_1 - 3,4x_2 + 7,8x_3 - 1,8x_4 &= 15,1. \end{aligned} \right\}$$

$$3. \left. \begin{aligned} -3,1x_1 + 2x_2 - 4x_3 + 5x_4 &= 4,9, \\ 2x_1 - x_2 + x_3 + 1,2x_4 &= -9,7, \\ x_1 - 3x_2 - 2x_3 + 2,7x_4 &= 13,1, \\ 5x_1 - x_2 + 3x_3 + 7,8x_4 &= 10,6. \end{aligned} \right\}$$

$$4. \left. \begin{aligned} 2,6x_1 - 3,1x_2 + 3,4x_3 + 2,5x_4 &= 3,5, \\ 6,6x_1 + 9,9x_2 - 2,3x_3 - 0,1x_4 &= -4,3, \\ 10,1x_1 + 3,2x_2 - 3,7x_3 - 2,8x_4 &= 3,8, \\ 8,9x_1 + 6,4x_2 + 1,1x_3 + 3,9x_4 &= -7,8. \end{aligned} \right\}$$

$$5. \left. \begin{aligned} 3,5x_1 + 0,2x_2 + 3,8x_3 - 0,3x_4 &= 0,8, \\ 4,5x_1 + 2,1x_2 - 0,1x_3 - 0,2x_4 &= 1,1, \\ -2,1x_1 + 3,2x_2 + 0,2x_3 - 0,2x_4 &= 0,2, \\ 3,2x_1 + 1,8x_2 - 3,2x_3 + 0,2x_4 &= 0,1.. \end{aligned} \right\}$$

$$6. \left. \begin{aligned} 1,1x_1 + 2,3x_2 + 5,5x_3 + 2,3x_4 &= 7,9, \\ 3,3x_1 + 1,3x_2 + 1,8x_3 + 3,1x_4 &= 2,6, \\ 2,6x_1 + 4,3x_2 + 1,1x_3 + 1,7x_4 &= 10,6, \\ 1,1x_1 + 3,8x_2 + 2,9x_3 + 2,7x_4 &= 9,3. \end{aligned} \right\}$$

$$7. \left. \begin{aligned} 1,3x_1 + 3,2x_2 + 2,1x_3 + 3,3x_4 &= 1,9, \\ 3,5x_1 - 4,1x_2 - 5,3x_3 - 2,5x_4 &= -4,7, \\ 2,8x_1 + 3,5x_2 - 7,6x_3 - 4,9x_4 &= -6,7, \\ 1,4x_1 + 2,8x_2 + 3,9x_3 - 1,8x_4 &= -4,8. \end{aligned} \right\}$$

$$8. \left. \begin{aligned} 0,2x_1 + 0,8x_2 - 0,1x_3 + 0,2x_4 &= 0,1, \\ 0,8x_1 + 1,1x_2 + 0,1x_3 + 1,1x_4 &= 2,3, \\ -0,3x_1 + 0,1x_2 + 3,0x_3 - 2,0x_4 &= 0,1, \\ 0,1x_1 + 1,1x_2 + 1,1x_3 - 1,3x_4 &= 0,2. \end{aligned} \right\}$$

$$9. \left. \begin{aligned} 1,1x_1 + 1,3x_2 - 6,3x_3 - 4,5x_4 &= 6,3, \\ 3,9x_1 - 0,7x_2 - 6,8x_3 - 4,7x_4 &= 2,7, \\ 2,8x_1 + 3,3x_2 + 9,1x_3 + 2,8x_4 &= 6,9, \\ 3,1x_1 + 2,7x_2 + 3,4x_3 - 8,1x_4 &= -7,1. \end{aligned} \right\}$$

$$10. \left. \begin{aligned} 1,1x_1 + 2,3x_2 + 3,4x_3 - 2,0x_4 &= 6,5, \\ 2,8x_1 - 1,2x_2 - 2,3x_3 - 3,9x_4 &= 8,8, \\ 3,9x_1 + 2,8x_2 - 1,3x_3 + 2,8x_4 &= 4,1, \\ 2,7x_1 - 3,6x_2 + 2,6x_3 + 1,7x_4 &= -8,7. \end{aligned} \right\}$$

$$11. \left. \begin{aligned} 6,1x_1 - x_2 - x_3 + 1,5x_4 &= 7,6, \\ -x_1 + 6,3x_2 - x_3 + 5,7x_4 &= 3,9, \\ -x_1 - x_2 + 6,7x_3 + 3,4x_4 &= 4,6, \\ 2,2x_1 - x_2 + 3,1x_3 - 1,4x_4 &= 7,2. \end{aligned} \right\}$$

$$12. \left. \begin{aligned} 2,3x_1 - 1,1x_2 + 3,4x_3 + 2,6x_4 &= 4,3, \\ 3,4x_1 + 3,8x_2 + 3,6x_3 - 2,1x_4 &= 6,5, \\ 3,9x_1 - 0,3x_2 - 0,1x_3 + 2,3x_4 &= 6,3, \\ 3,1x_1 - 0,7x_2 + 3,8x_3 - 1,1x_4 &= 5,1. \end{aligned} \right\}$$

$$13. \left. \begin{aligned} -x_1 + 0,1x_2 - 2,1x_3 - 0,1x_4 &= 0,2, \\ 0,8x_1 + 0,2x_2 - 0,2x_3 - 0,8x_4 &= 1,4, \\ 0,3x_1 - 0,2x_2 + 0,4x_3 + 0,5x_4 &= 2,1, \\ 1,1x_1 + 3,1x_2 + 0,2x_3 - 1,1x_4 &= -0,1. \end{aligned} \right\}$$

$$14. \left. \begin{aligned} 0,7x_1 - x_2 + 3,2x_3 + 4,1x_4 &= 0,1, \\ x_1 + x_2 - 8,3x_3 + 2,4x_4 &= 10,2, \\ 3,8x_1 - 0,5x_2 - 2,4x_3 + 8,8x_4 &= 1,1, \\ 8,3x_1 + 7,3x_2 - 0,7x_3 + 10,1x_4 &= 9,2. \end{aligned} \right\}$$

$$15. \left. \begin{aligned} 2,1x_1 + 3,3x_2 - 0,7x_3 + 0,1x_4 &= 1,1, \\ 8,3x_1 + 12,1x_2 - 9,3x_3 + 8,7x_4 &= 3,3, \\ 4,8x_1 + 6,2x_2 + 3,4x_3 - 2,5x_4 &= 3,5, \\ 2,6x_1 + 3,7x_2 + 9,8x_3 - 7,6x_4 &= 3,4. \end{aligned} \right\}$$

$$16. \left. \begin{aligned} 0,1x_1 + 0,3x_2 + 0,4x_3 + 0,2x_4 &= 0,1, \\ 0,3x_1 + 2,1x_2 + 3,4x_3 + 4,6x_4 &= 6,2, \\ 0,5x_1 + 3,3x_2 + 6,4x_3 + 10,1x_4 &= 8,3, \\ 0,2x_1 + 4,1x_2 + 10,3x_3 + 2,9x_4 &= 9,2. \end{aligned} \right\}$$

$$\begin{array}{l}
17. \left. \begin{array}{l} x_1 - 6,3x_2 + 1,2x_3 - 5,9x_4 = 7,1, \\ -3,8x_1 - 7,2x_2 + 2,4x_3 - x_4 = 7,9, \\ 6,1x_1 - 5,6x_2 - 4,1x_3 + x_4 = 9,4, \\ x_1 + 2,3x_2 - 0,7x_3 + 9,1x_4 = 11,2. \end{array} \right\} \\
18. \left. \begin{array}{l} 2,2x_1 - 3,2x_2 + 1,2x_3 - 0,9x_4 = 0,5, \\ 1,5x_1 + 2,1x_2 - 0,5x_3 + 1,4x_4 = 1,5, \\ 0,9x_1 - 1,4x_2 + 0,6x_3 + 0,3x_4 = -0,1, \\ 0,5x_1 + 1,3x_2 - 0,6x_3 - 0,9x_4 = 0,4. \end{array} \right\} \\
19. \left. \begin{array}{l} 4,1x_1 - 3,3x_2 + 2,4x_3 - 0,7x_4 = 8,1, \\ 3,2x_1 - 2,1x_2 + 0,5x_3 - 3,2x_4 = 7,2, \\ 2,4x_1 - 0,2x_2 + 0,1x_3 - 5,1x_4 = 6,3, \\ 5,3x_1 - 3,1x_2 + 0,3x_3 + 8,2x_4 = 1,1. \end{array} \right\} \\
20. \left. \begin{array}{l} 3,1x_1 - 0,1x_2 + 1,1x_3 - 0,2x_4 = 1,1, \\ -1,8x_1 + 1,1x_2 + 0,1x_3 - 0,8x_4 = 0,1, \\ 0,2x_1 - 2,1x_2 + 0,7x_3 - 1,7x_4 = 1,2, \\ 0,2x_1 + 0,2x_2 + 0,4x_3 + 0,3x_4 = 0,2. \end{array} \right\} \\
21. \left. \begin{array}{l} 0,6x_1 + 0,8x_2 + 4,1x_3 + 5,2x_4 = 7,9, \\ -3,2x_1 + 2,1x_2 - x_3 + 3,4x_4 = 1,9, \\ -2,5x_1 + 3,9x_2 + 2,2x_3 - 1,3x_4 = 3,9, \\ 1,4x_1 - x_2 - 3,4x_3 - 1,6x_4 = 5,6. \end{array} \right\} \\
22. \left. \begin{array}{l} 2,1x_1 - 0,1x_2 + 0,3x_3 - 0,3x_4 = 3,1, \\ 4,3x_1 - 2,3x_2 - 2,4x_3 + 3,3x_4 = 2,7, \\ 2,4x_1 - 0,1x_2 + 5,3x_3 - 6,1x_4 = 1,1, \\ 2,3x_1 - 0,4x_2 - 3,3x_3 + 4,3x_4 = 5,4. \end{array} \right\} \\
23. \left. \begin{array}{l} 0,8x_1 + 0,7x_2 - 0,8x_3 + 4,2x_4 = 2,2, \\ 0,6x_1 - 0,8x_2 + 1,4x_3 - 0,6x_4 = 1,7, \\ 0,9x_1 + 0,8x_2 - 1,8x_3 + 0,9x_4 = -0,5, \\ 1,3x_1 - 0,5x_2 - 0,7x_3 + 1,2x_4 = 0,7. \end{array} \right\} \\
24. \left. \begin{array}{l} 0,6x_1 + 1,1x_2 + 0,7x_3 + 0,03x_4 = 2,0, \\ 1,8x_1 + 0,9x_2 - 0,6x_3 + 0,7x_4 = 0,2, \\ 2,7x_1 - 0,8x_2 + 1,2x_3 - 2,4x_4 = 1,3, \\ 3,6x_1 + 0,2x_2 - 3,4x_3 - 1,2x_4 = 0,1. \end{array} \right\} \\
25. \left. \begin{array}{l} x_1 + 2,3x_2 + 3,4x_3 + 4,6x_4 = 5,6, \\ 2,7x_1 + 1,1x_2 + 2,7x_3 - 3,7x_4 = 1,9, \\ -3,8x_1 + 2,8x_2 + 1,4x_3 + 2,8x_4 = 1,7, \\ 4,5x_1 + 3,9x_2 + 2,5x_3 + 1,6x_4 = -5,3. \end{array} \right\}
\end{array}$$

Vazifani bajarish uchun kursatma: Gaussning klassik usuli tugri va teskari yurishlardan iboratdir. Tugri yurishda sistemaning asosiy matritsasi, noma'lumlarni birin ketin yukotish natijasida trapetsiya yoki uchburchakli shaklga keltiriladi. Teskari yurishda uning noma'lumlari ketma-ket aniklanadi va umumiy echim kuriladi.

Q'uyidagi tenglamalar sistemasi berilgan bo'lsin:

$$\left. \begin{aligned} 1,1x_1 + 2,3x_2 + 3,4x_3 - 2,0x_4 &= 6,5, \\ 2,8x_1 - 1,2x_2 - 2,3x_3 - 3,9x_4 &= 8,8, \\ 3,9x_1 + 2,8x_2 - 1,3x_3 + 2,8x_4 &= 4,1, \\ 2,7x_1 - 3,6x_2 + 2,6x_3 + 1,7x_4 &= -8,7. \end{aligned} \right\}$$

Dastur kodining boshlanishida sistemadagi noma'lumlar soni va sistemadagi tenglamalar sonini belgilaydigan konstanta **n** uchun tegishli q'iyamat kiritamiz, masalan uch noma'lumli uchta tenglamadan iborat sistema uchun **n=3**. h_1, h_2, h_3, h_4 o'zgaruvchilar oldidagi ko'effitsientlarni va sistemani o'ng tomonidagi ozod hadlarni dastur kodiga kiritib q'uidagi natijani olamiz:

$$\begin{aligned} h_1 &= 2.6372176354E+00 \\ h_2 &= 7.9322297761E-01 \\ h_3 &= -6.2607093330E-01 \\ h_4 &= -1.8050300306E+00 \end{aligned}$$

CHATS echimlarini topish uchun Gauss usuliga tuzilgan dastur kodi.

```
Program Gaus; uses crt;
const n=3;
var A: array [1..n,1..n] of Real ;
    B: array [1..n] of Real ;
    x: array [1..n] of Real ;
    i, j, k: Integer ;
    L, G: Real;
Begin clrscr; Writeln ;
for i:=1 to n do
    x[i]: =0 ; Writeln('ozod hadlarini kiriting:');
for i:=1 to n do
begin
    Write ('B['i,']=') ; Read (B[i]) ;
end; Writeln('noma'lumlar oldidagi ko'effitsientlarni
kiriting:');
```

```

for i:=1 to n do
  for j:=1 to n do begin
    Write('A[' ,i ,',' ,j ,']='); read (A[i,j])
    End ;
  for k:=1 to (n-1) do
    for i:=(k+1) to n do
      begin
        L:=A[i,k] / A[k,k] ;
        B[i ]:=B[i ] - L*B[k] ;
        for j:=k to n do
          A[i,j]:=A[i,j]-L*A[k,j];
        end;
      x[n]:=B[n] / A[n , n];
    for i:= (n-1) downto 1 do
      begin
        for k:= (i+1) to n do
          G:=G+A[i ,k]*x[k];
          x[i ]:=1/A[i , i ]*(B[i ]-G);
          G:=0;
        end;
      writeln; writeln ('sistema echimlari:');
    for i:=1 to n do
      begin writeln ;
        write ('X[' , i ,']=', ' ',x[i ]:6:4);
      end;
    end.

```

Laboratoriya ishi № 4.

BIRINCHI TARTIBLI ODDIY DIFFERENTIAL TENGLAMALAR ECHIMLARINI TAKRIBIY USULLAR BILAN HISOBLASH

Vazifa: Berilgan birinchi tartibli oddiy differentsial tenglama $y'=f(x,y)$ uchun, argumentining $[0;1]$ oraligida $h=0.1$ q'adam bilan Eýler va Runge-Kutta usullari yordamida Koshi masalasini takribiy echimini topish algoritmi va dasturlash tilida dastur kodini tuzing.

Laboratoriya ishiga doir topshiriq' variantlari:

a) - variant

№	Tenglama	Boshlanfich shart
1	$y' = (x+1)^{1/2}y - 0,5x^2$	$y(0) = 1,2$
2	$y' = (x^2+1)^{1/2}y + 4,5x$	$y(0) = 1,4$
3	$y' = 3,4x^2y - 2,8x^2$	$y(0) = 0,6$

4	$y' = (x + 3)^{1/2} y - 1,3x^2$	$y(0) = 1,6$
5	$y' = 4,5x^2 + y - 6,4x + 1$	$y(0) = 4,2$
6	$y' = 2,7x^2 y + 3,8x + y$	$y(0) = 4,6$
7	$y' = 8,5x^3 y + \sin x^2$	$y(0) = 2,8$
8	$y' = 5,2x - y + 4,8x^3$	$y(0) = 4,2$
9	$y' = 4,2xy + x^2 - \cos x$	$y(0) = 4,8$
10	$y' = 5,4xy + 1,5x^2 + \ln y$	$y(0) = 2,6$
11	$y' = 8,6x^3 y - 5,1x^2 + 2$	$y(0) = 4,2$
12	$y' = (3,5x + 1)y + x^2 + 1,6$	$y(0) = 2,6$
13	$y' = (2x + 5)^{1/2} y + 1,5x^2$	$y(0) = 2,4$
14	$y' = (x^2 - 1)^{1/3} y - 0,6x^2$	$y(0) = 1,2$
15	$y' = (2x + 1)^{1/2} y + 3,4x^2 + 1,2$	$y(0) = 1,2$
16	$y' = (3x^2 + 1)y - 3,4x^2 + 1,4$	$y(0) = 1,5$
17	$y' = (4x^2 + 1)y - 3,5x^2 + 1,2$	$y(0) = 1,6$
18	$y' = (4x^2 - 1)y + 1,8x^3 - 12$	$y(0) = 1,2$
19	$y' = x^{1/2} + 7x^3 y - 3x^2$	$y(0) = 3,2$
20	$y' = 4,6x^3 + 2x^3 + 2,8$	$y(0) = 2,9$
21	$y' = 4,2x^3 y - 2,6x^2$	$y(0) = 4,7$
22	$y' = 3x + 1,9y^2 - 5xy$	$y(0) = 0,2$
23	$y' = x^2 + xy + \cos x$	$y(0) = 0,2$
24	$y' = x^2 + y - \ln y$	$y(0) = 0,4$
25	$y' = xy + y^2 + \sin y$	$y(0) = 0,6$
26	$y' = 0,1x + 0,2y^2 + 5y$	$y(0) = 0,2$
27	$y' = 2x^2 + xy - \sin x$	$y(0) = 0,5$
28	$y' = x^2 + 0,2xy$	$y(0) = 0,6$
29	$y' = x^2 + 3xy - \log_2 x$	$y(0) = 0,3$
30	$y' = 2x^2 + 3y^2 + 5xy$	$y(0) = 0,2$

b) - variant

№	Tenglama	Boshlanrich shart
1	$y' = X^3 \sin y + 1$	$y(0) = 0.0$
2	$y' = X^2 \sin y - 1$	$y(0) = 0.1$
3	$y' = e^x + 3y$	$y(0) = 2.0$
4	$y' = y^2 + x^3$	$y(0) = 0.3$
5	$y' = Y^3 + x^2$	$y(0) = 0.4$
6	$y' = 1/(1+y^2) + x^2$	$y(0) = 0.0$
7	$y' = 1/(1+y^2) + xy$	$y(0) = 0.1$
8	$y' = \cos y + xy$	$y(0) = 0.2$
9	$y' = X^2 \cos y + 0.1$	$y(0) = 0.3$
10	$y' = X^3 \cos y + 0.1$	$y(0) = 0.4$
11	$y' = \text{Cos}(xy) - 0.5$	$y(0) = 0.5$

12	$y' = e^{-y} + e^x - 2$	$y(0) = 0.0$
13	$y' = e^{-y} - e^x - 0.1$	$y(0) = 0.5$
14	$y' = e^{-xy} + 1$	$y(0) = 0.4$
15	$y' = Y^2 + x^4$	$y(0) = 0.3$
16	$y' = Xy^2 + x^{(1/2)}$	$y(0) = 0.2$
17	$y' = \text{Cos}(x+y) + x^2$	$y(0) = 0.1$
18	$y' = \text{sin}(x+y) - x^2$	$y(0) = 0.0$
19	$y' = \text{Sin}(xy) + 1$	$y(0) = 0.1$
20	$y' = \text{Sin } x + xy$	$y(0) = 0.2$
21	$y' = (x^2 + y^2)x$	$y(0) = 0.3$
22	$y' = e^x(1+xy)$	$y(0) = 0.4$
23	$y' = e^y(1+xy)$	$y(0) = 0.5$
24	$y' = \text{Ln}(1+x^2) + y$	$y(0) = 0.6$
25	$y' = 1 + ye^{xx}$	$y(0) = 0.7$
26	$y' = \text{Sin } x^2 + y^2$	$y(0) = 0.0$
27	$y' = \text{Cos } x^2 + xy$	$y(0) = 0.1$
28	$y' = \text{Sin } y/(1+x^2) + 1$	$y(0) = 0.2$
29	$y' = \text{Ln}(1+y^2) + x$	$y(0) = 0.3$
30	$y' = 1 + xe^{yy}$	$y(0) = 0.4$

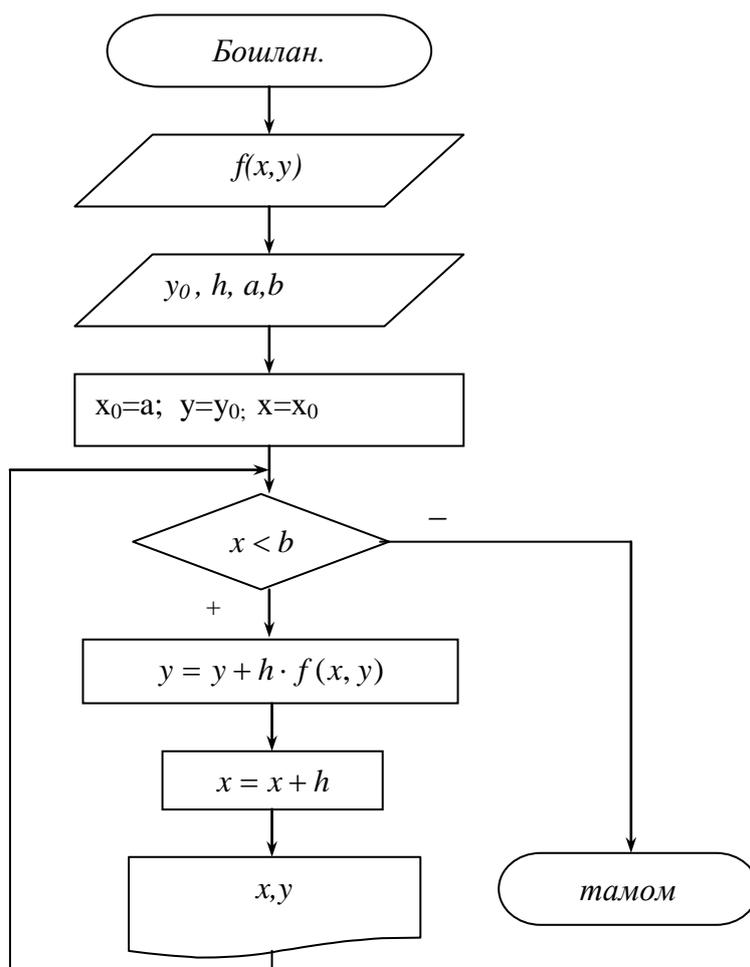
1-Vazifa. Berilgan birinchi tartibli oddiy differentsial tenglama $y'=f(x,y)$ uchun, argumentini $[0;1]$ oraligida $h=0.1$ q'adam uchun, E'ylar usuli bilan Koshi masalasini takribiy echimini toping. Algoritmini tuzing va dasturlash tilida dastur kodini tuzib natija oling.

1-vazifani bajarish uchun ko'rsatma:

E'ylar usuli bilan hisoblash algoritmi. Birinchi tartibli oddiy differentsial tenglamaning sonli echimlarini E'ylar usuli bilan hisoblash uchun q'uyidagi algoritmdan foydalanamiz:

1. Sonli echimlar q'idiriladigan oraliq'ni teng bo'laklarga bo'lish uchun bo'linishlar soni n ni kiritamiz hamda a va b chegara nuq'talaridan foydalanib bo'linish nuq'talari orasidagi q'adamni hisoblaymiz $h = (b - a) / n$ va x_k ($k = 0,1,2,\dots, n$) bo'linish nuq'talarini hosil q'ilamiz.

2. $y_{k+1} = y_k + \Delta y_k$ iteratsion formuladan foydalanish uchun h_k o'zgaruvchiga birinchi q'iyamat sifatida chap chegaraviy nuq'ta a ning q'iyamatini beramiz, y_k ga esa noma'lum funktsiyaning boshlanfich q'iyamati u_0 ni beramiz.
3. Aniq'langan x_k va y_k q'iyamlari uchun $\Delta y_k = h \cdot f(x_k, y_k)$ ni hisoblaymiz.
4. $y_{k+1} = y_k + \Delta y_k$ ($k=0,1,2,\dots, n$) iteratsion formuladan noma'lum funktsiyani keyingi bo'linish nuq'tasidagi q'iyamatini hisoblaymiz. So'ngra $y_k = y_{k+1}$ almashtirishni bajarib keyingi bo'linish nuq'tasi h_k ga o'tamiz va o'ng chegaraviy nuq'ta b ga etmaguncha 3-bosq'ichga q'aytamiz.
5. h_k q'abul q'iladigan q'iyamati o'ng chegaraviy nuq'ta b ga etib kelganda so'ngi marotaba $y_{k+1} = y_k + \Delta y_k$ formuladan foydalanib noma'lum funktsiyaning ohirgi nuq'tadagi q'iyamatini hisoblaymiz.



Эйлер usuli algoritmini блок-шema kurinishi:

Birinchi tartibli oddiy differentsial tenglama sonli echimini Eýler usuli bilan hisoblash uchun dastur kodi:

```
program Eyiler; Uses crt;
var a, b, h, x, y0, y, y1, F : real; n : integer;
begin clrscr;
writeln('oralikni chap chegarasi - a va unq chegarasi - b ni kiriting');
read(a,b);
writeln('noma'lum funktsiyaning bosh kiymati - u0 ni kiriting');
readln ( y0 );
writeln ('bulinishlar soni- n ni kiriting');
read( n ); h:=(b-a)/n;
x:=a; y:=y0;
while x<=b do begin
F:= x-y; // tenglamani o'ng tomonini kiriting
y1:=y + h*F;
writeln('x=',x,'y1=',y1);
x:=x+h;
y:=y1;
end;
end.
```

2-Vazifa . Runge-Kutta usuli bilan, berilgan birinchi tartibli oddiy differentsial tenglama $y'=f(x,y)$ uchun, argumentining $[0;1]$ oraligida $h=0.1$ q'adam bilan Koshi masalasini echimini toping. Algoritmini tuzing va dasturlash tilida dastur kodini tuzib natija oling.

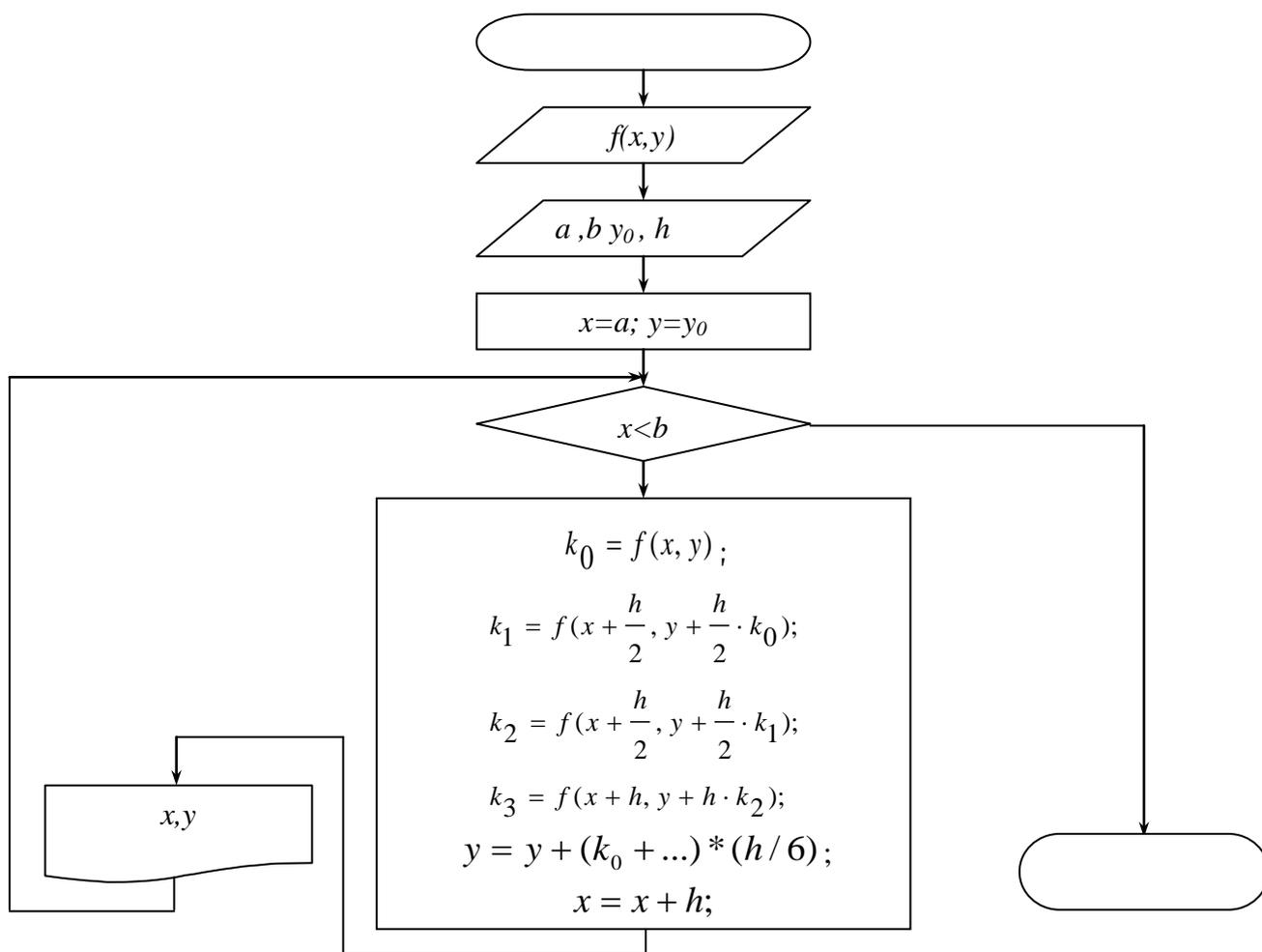
2- vazifani bajarish uchun kursatma:

Runge-Kutta usuli bilan hisoblash algoritmi. Birinchi tartibli oddiy differentsial tenglamaning sonli echimlarini Runge-Kutta usuli bilan hisoblash uchun q'uyidagi algoritmdan foydalanamiz:

1. Sonli echimlar q'idiriladigan oraliq'ni teng bo'laklarga bo'lish uchun bo'linishlar soni n ni kiritamiz hamda a va b chegara nuq'talaridan foydalanib bo'linish nuq'talari orasidagi q'adamni hisoblaymiz $h = (b - a) / n$ va x_i ($i = 0, 1, 2, \dots, n$) bo'linish nuq'talarini hosil q'ilamiz.

2. $y_{i+1} = y_i + \Delta y_i$ iteratsion formuladan foydalanish uchun h_i o'zgaruvchiga birinchi q'iyamat sifatida chap chegaraviy nuq'ta a ning q'iyamatini beramiz, y_i ga esa noma'lum funktsiyaning boshlanfich q'iymati u_0 ni beramiz.

3. x_i va y_i q'iymlari uchun uchun $K_1^{(i)}$, $K_2^{(i)}$, $K_3^{(i)}$, $K_4^{(i)}$ ko'effitsientlarni hisoblaymiz va $\Delta y_i = (1/6) \cdot (K_1^{(i)} + 2 K_2^{(i)} + 2 K_3^{(i)} + K_4^{(i)})$ ni hosil q'ilamiz.
4. $y_{i+1} = y_i + \Delta y_i$ ($i=0,1,2,\dots, n$) iteratsion formuladan noma'lum funktsiyani keyingi bo'linish nuq'tasidagi q'iymatini hisoblaymiz. So'ngra $y_i = y_{i+1}$ almashtirishni bajarib keyingi bo'linish nuq'tasi h_i ga o'tamiz va o'ng chegaraviy nuq'ta b ga etmaguncha 3-bosq'ichga q'aytamiz.
5. h_i q'abul q'iladigan q'iymati o'ng chegaraviy nuq'ta b ga etib kelganda so'ngi marotaba $y_{i+1} = y_i + \Delta y_i$ formuladan foydalanib noma'lum funktsiyaning ohirgi nuq'tadagi q'iymatini hisoblaymiz.



Runge-Kutta usulining algoritmi blok-shema kurinishida:

Birinchi tartibli oddiy differentsial tenglamani sonli echimini Runge-Kutta usuli bilan hisoblash uchun dastur kodi:

```

program RungeKutta; Uses crt;
label 1;
var a,b,h,x,y0,y,y1,k1,k2,k3,k4,k:real; n:integer;
  
```

```

function F(x,y : real) : real ;
begin
F:=x-y // tenglamani o'ng tomonini kiriting
end ;
begin clrscr;
writeln('oraliq'ni chap chegarasi - a va o'ng chegarasi- b ni kiriting');
read(a,b);
writeln (' noma'lum funktsiyaning bosh kiymati – u0 ni kiriting');
readln ( y0 );
writeln ('bo'linishlar soni - n ni kiriting');
read( n ); h:= (b-a)/n;
x:=a; y:=y0;
1:k1:=h*F(x,y);
k2:=h*F(x+h/2,y+k1/2);
k3:=h*F(x+h/2,y+k2/2);
k4:=h*F(x+h,y+k3);
k:=(1/6)*(k1+2*k2+2*k3+k4);
y1:=y+k;
writeln('x=',x, 'Y=', y1);
if x < b then
begin
x:=x+h; y:=y1; goto 1
end;
end.

```

Laboratoriya ishi №5.

ANIK INTEGRALNI TAKRIBIY USULLAR BILAN HISOBLASH

1-Vazifa. Anik integralni tugri turtburchaklar usuli bilan hisoblang.

Algoritmini tuzib dasturlash tilida dastur kodini yozing va natija oling.

2-Vazifa. Anik integralni trapetsiya usuli bilan hisoblang. Algoritmini tuzib dasturlash tilida dastur kodini yozing va natija oling.

3-Vazifa. Anik integralni Simpson usuli bilan hisoblang. Algoritmini tuzib dasturlash tilida dastur kodini yozing va natija oling.

Laboratoriya ishiga doir topshiriq' variantlari:

- | | | |
|----|---|--|
| 1. | a) $\int_{0,8}^{1,6} \frac{x \sin x dx}{\sqrt{2x^2 + 1}}$ | b) $\int_{0,6}^{1,4} \frac{\cos x}{x+1} dx$ |
| 2. | a) $\int_{1,2}^{2,4} \frac{dx}{\sqrt{0,5+x^2}}$ | b) $\int_{0,4}^{12} \sqrt{x} \cdot \cos(x^2) dx$ |
| 3. | a) $\int_{1,4}^{2,1} \frac{dx}{\sqrt{3x^2 + 1}}$ | b) $\int_{0,8}^{1,2} \frac{\sin(2x)}{x^2} dx$ |

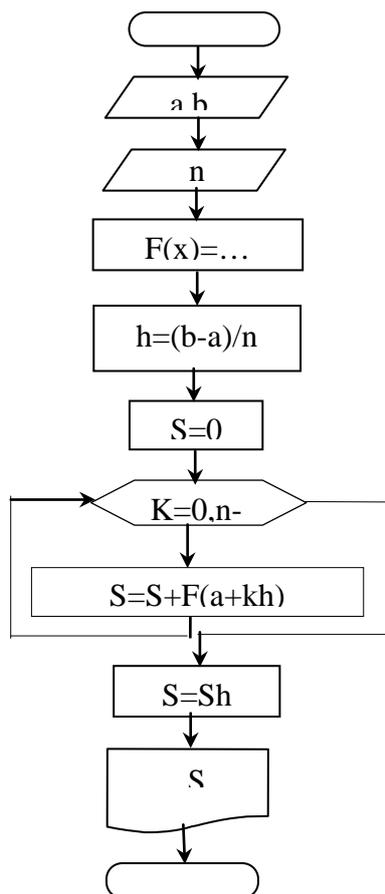
4. a) $\int_{0,2}^{1,2} \frac{dx}{\sqrt{x^2 + 1}}$ b) $\int_{1,2}^2 \frac{\lg(x+2)}{x} dx$
5. a) $\int_{0,8}^{1,4} \frac{dx}{\sqrt{2x^2 + 3}}$ b) $\int_{1,6}^{2,4} (x+1) \sin x dx$
6. a) $\int_{0,4}^{1,2} \frac{dx}{\sqrt{2+0,5x^2}}$ b) $\int_{0,2}^1 \frac{\text{tg}(x^{2;})}{x^2 + 1} dx$
7. a) $\int_{1,2}^2 \frac{dx}{\sqrt{2x^2 + 1,3}}$ b) $\int_{1,2}^{8,9} \frac{\sin^2 x}{\sqrt{1 + \sin^2 x}} dx, h = 0,77.$
8. a) $\int_{1,2}^{2,7} \frac{1}{\sqrt{x^2 + 3,2}} dx$ b) $\int_0^{3,4} \frac{\cos^2 x}{\sqrt{1 + \sin^2 x}} dx, h = 0,17.$
9. a) $\int_{0,4}^{1,2} \frac{dx}{\sqrt{3 + x^2}}$ b) $\int_1^{11} x \sqrt{1 + 2x} dx, h = 1.$
10. a) $\int_{0,6}^{1,5} \frac{dx}{\sqrt{1 + 2x^2}}$ b) $\int_{0,4}^{0,8} \frac{\lg(x^2 + 0,5)}{1 + 2x^2} dx$
11. a) $\int_{0,8}^{1,6} \frac{dx}{\sqrt{2x^2 + x + 1}}$ b) $\int_{1,2}^2 \frac{x^2 \text{ctg}(x+2)}{x+3} dx$
12. a) $\int_{0,8}^{1,6} \frac{dx}{\sqrt{2x^2 + 1}}$ b) $\int_{1,2}^2 \frac{\lg(x-1)}{\sin x} dx$
13. a) $\int_{0,8}^{1,6} \frac{\text{ctg} x dx}{\sqrt{4x^3 - x}}$ b) $\int_{1,4}^{2,2} \frac{x+5}{\text{tg} x - 2} dx$
14. a) $\int_{0,5}^{1,6} \frac{(x-5) dx}{\sqrt{x + \lg x}}$ b) $\int_{1,8}^{2, \square} \sqrt{\frac{x \sin x}{x + 2 \lg x}} dx$
15. a) $\int_{0,8}^{1,8} \frac{x^4 dx}{\sqrt{x \lg x}}$ b) $\int_{1,2}^2 \frac{\lg(x-5)}{x^2 - 1} dx$
16. a) $\int_{2,4}^{3,6} \frac{(x + \ln x) dx}{\sin(x+1)}$ б) $\int_{1,2}^2 \frac{\lg(x+2)}{x} dx$
17. a) $\int_{0,8}^{1,6} \frac{x^2 dx}{\sqrt{2x + \lg x}}$ b) $\int_{1,6}^2 \frac{\text{tg}(x-3)}{x - \sin x} dx$
18. a) $\int_{0,4}^{1,2} \frac{\sin x dx}{x^3 \sqrt{x+2}}$ □) $\int_{1,2}^2 \frac{\sin(x+1)}{x \sqrt{x+1}} dx$
19. a) $\int_{0,8}^{1,6} \frac{x \cos x dx}{\sqrt{x+5}}$ b) $\int_{1,2}^2 \frac{\sin(x+2)x}{3x} dx$
20. a) $\int_{0,8}^{1,6} \frac{(2 + \ln x) dx}{x \sin(x+1)}$ b) $\int_{1,2}^{2,4} \frac{\text{tg}(x+2)}{x \ln x} dx$

21. a) $\int_{0,8}^{1,6} \frac{dx}{\sqrt{2x^2 + 1}}$ b) $\int_{1,2}^2 \frac{\lg(x+2)}{x} dx$
22. a) $\int_{1,8}^{2,8} \frac{x^3 - 2\sin x dx}{\sqrt{x+1}}$ b) $\int_{1,2}^2 \frac{\cos(x+2)}{x^3 \operatorname{tg} x} dx$
23. a) $\int_{1,2}^{1,8} \frac{\sqrt{x+5} dx}{\sin(x+2)}$ b) $\int_{1,2}^2 \frac{2\lg x}{x \operatorname{tg}(x-1)} dx$
24. a) $\int_{1,2}^{1,8} \frac{x\sqrt{x+6} dx}{\sin x}$ b) $\int_{1,2}^{2,2} \frac{x \lg(x+1)}{\cos x} dx$
25. a) $\int_{0,8}^{1,6} \frac{\sin x dx}{\sqrt{2 \operatorname{ctg} x + 1}}$ b) $\int_{1,2}^2 \frac{\operatorname{tg}(x+1)}{x \sin x} dx$

1- vazifani bajarish uchun kursatma:

Tugri turtburchaklar usulining ishchi formulasi:

$$S = \int_b^a f(x) dx \approx h[f(a+h) + \dots + f(a+(n-1)h)] = h \cdot \sum_{k=0}^{n-1} f(a+kh) \quad ; h = (b-a)/n; n=10.$$



Tugri turtburchaklar usulining algoritmi:

Tugri turtburchaklar usuli uchun dastur kodi:

program Turtburchak;
var a,b,s, h:real;

```

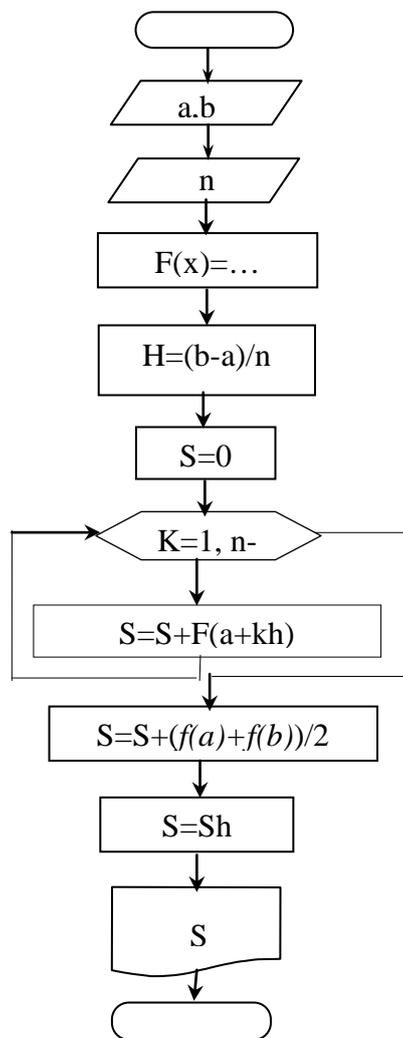
n,k:integer;
function F(x:real):real;
begin F:=... end;
begin writeln ('a,b='); readln (a,b);
      writeln('n='); readln (n);
      h:=(b-a)/n; s:=0;
      for k:=0 to n-1 do
      s:=s+f(a+k*h);
      s:=s*h; writeln(' natija=',s); end.

```

2- vazifani bajarish uchun kursatma:

Trapetsiya usulining ishchi formulasi:

$$S = \int_a^b f(x)dx = h \cdot \left[\frac{f(a) + f(b)}{2} + \sum_{k=1}^{n-1} f(a + kh) \right]; \quad h = (b-a)/n; \quad n=10.$$



Trapetsiya usulining algoritmi:

Trapetsiya usuli uchun dastur kodi:

```

Program Trapetsia;
var a,b,h,S:real; n,k:byte;

```

```

function f(x:real):real;
  begin f:= .... end;
begin
  write('a,b=');
  readln(a,b); write(' n= ');
  readln(n); h:=(b-a)/N; s:=0;
  for k:=1 to n-1 do
    s:=s+f(a+k*h); s:=s+(f(a)+f(b))/2; s:=s*h; writeln('natija s=',s); end.

```

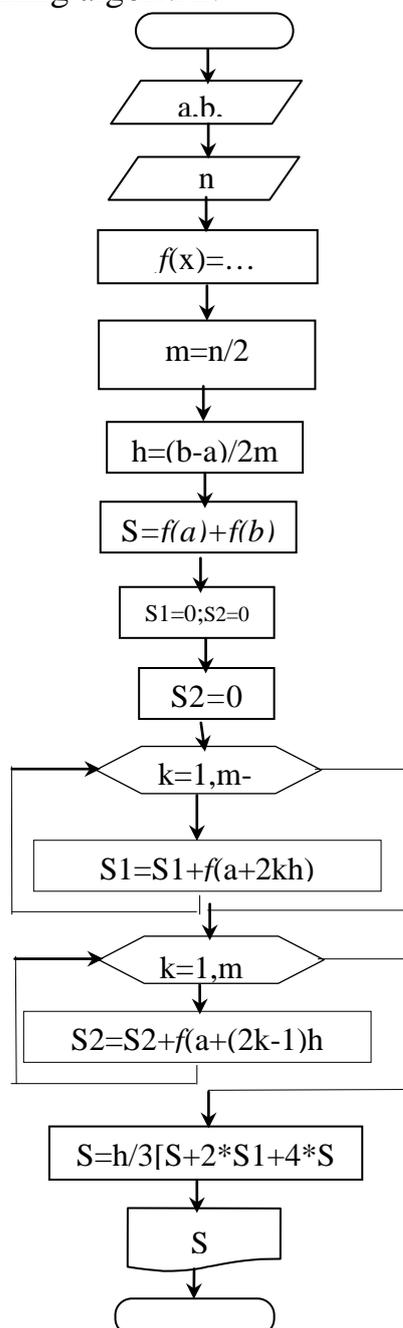
3- vazifani bajarish uchun kursatma:

Simpson usulining ishchi formulasi:

$$S = \int_a^b f(x)dx = \frac{h}{3} \left[f(a) + f(b) + 2 \cdot \sum_{k=1}^n f(a + (2k-1)h) + 4 \cdot \sum_{k=1}^n f(a + 2kh) \right]; h = (b-a)/n;$$

n=10.

Simpson usulining algoritmi:



Simpson usulining dastur kodi:

```

Program Simpson;
var a,b,h,s,s1,s2:real;
k,m,n:byte;
function f(x:real):real;
begin f:=... end;
begin
write('a,b kiriting'); readln( a,b);
write('n='); readln(n);
m:=n*2; h:=(b-a)/m; s:=f(a)+f(b); s1:=0; s2:=0;
for k:=1 to m-1 do s1:=s1+f(a+2*k*h);
for k:=1 to m do s2:=s2+f(a+(2*k-1)*h);
s:=h/3*(s+2*s1+4*s2);
writeln('s=',s);
end.

```

Laboratoriya ishi №6.**JADVAL KURINISHIDA BERILGAN FUNKTSIYA UCHUN INTERPOLYATSIYALOVCHI KUPHAD TUZISH**

Vazifa: Jadval kurinishida berilgan funktsiya uchun Lagranj usulidan foydalanib interpolyatsiyalovchi kuphad tuzing. Kuphadni hisoblash algoritmini tuzing, dasturlash tilida dastur kodini yozib natija oling.

Laboratoriya ishiga doir variantlar:

1		2		3	
X	Y	Y	X	Y	X
0.43	1.63597	0.702	0.02	1.02316	0.102
0.48	1.73234	0.512	0.08	1.09590	0.114
0.55	1.87686	0.645	0.12	1.14725	0.125
0.62	2.03345	0.736	0.17	1.21483	0.203
0.70	2.22846	0.608	0.23	1.30120	0.154
0.75	2.35973	0.646	0.30	1.40976	0.167

4		5		6	
X	Y	Y	X	Y	X
0.35	2.73951	0.526	0.41	2.57418	0.616
0.41	2.30080	0.453	0.46	2.32513	0.478
0.47	1.96864	0.482	0.52	2.09336	0.665
0.51	1.78776	0.552	0.60	1.86203	0.537
0.56	1.59502	0.436	0.65	1.74926	0.673
0.64	1.34310	0.378	0.72	1.62098	0.545

7		8		9	
X	Y	Y	X	Y	X
0.68	0.80.866	0.896	0.11	9.05421	0.314

0.73	0.89492	0.812	0.15	6.61659	0.235
0.80	1.02964	0.774	0.21	4.69170	0.332
0.88	1.20966	0.955	0.29	3.35106	0.275
0.93	1.34087	0.715	0.35	2.73951	0.186
0.99	1.52368	0.911	0.40	2.36522	0.167

10		11		12	
X	Y	Y	X	Y	X
1.375	5.04192	1.383	0.115	8.65729	0.1264
1.380	5.17744	1.392	0.120	8.29329	0.1315
1.385	5.32016	1.386	0.125	7.95829	0.1232
1.390	5.47069	1.393	0.130	7.64893	0.1334
1.395	5.62968	1.386	0.135	7.36235	0.1285
1.400	5.79788	1.356	0.140	7.09613	0.1211

13		14		15	
X	Y	Y	X	Y	X
0.150	6.61659	0.152	0.180	5.61543	0.1838
0.155	6.39989	0.161	0.185	5.46693	0.1875
0.160	6.19658	0.166	0.190	5.32634	0.1944
0.165	6.00551	0.154	0.195	5.19304	0.1976
0.170	5.82558	0.162	0.200	5.06649	0.2038
0.175	5.65583	0.146	0.205	4.94619	0.2111

16		17		18	
X	Y	Y	X	Y	X
0.210	4.83170	0.212	1.415	0.888551	1.4179
0.215	4.72261	0.216	1.420	0.889599	1.4258
0.220	4.61855	0.223	1.425	0.890637	1.4396
0.225	4.51919	0.226	1.430	0.891667	1.4236
0.230	4.42422	0.224	1.435	0.892687	1.4315
0.235	4.33337	0.186	1.440	0.893698	1.4456

Vazifani bajarish uchun kursatma:

Lagranj interpolyatsiya formulasidan interpolyatsiya nuq'talari orasidagi masofa bir hil bo'lmagan holda foydalaniladi.

$y = f(x)$ funktsiya uchun $[a, b]$ oraliq'ning $n+1$ nuq'tasida x_0, x_1, \dots, x_n $y_i = f(x_i)$ $f(x_0) = y_0, f(x_1) = y_1, \dots, f(x_n) = y_n$ q'iymatlarni q'abul q'ilsin. Daraja ko'rsatkichi n dan oshmaydigan shunday $L_n(x)$ polinom tuzish kerakki berilgan x_0, x_1, \dots, x_n nuq'talarda $f(x)$ funktsiya kabi q'iymatlarni q'abul q'ilsin, ya'ni $L_n(x_i) = y_i$.

Umumiy holda $n + 1$ interpolyatsiya nuq'tasi berilgan bo'lsa va bu nuq'talarda $U=f(X)$ funktsiya jadval ko'rinishda berilganida $n -$ darajali ko'phad q'uyidagicha aniq'lanadi:

$$L(x) = \sum_{k=0}^n y_k \frac{(h - h_0)(h - h_1) \dots (h - h_{k-1})(h - h_{k+1}) \dots (h - h_n)}{(h_k - h_0)(h_k - h_1) \dots (h_k - h_{k-1})(h_k - h_{k+1}) \dots (h_k - h_n)}$$

Hosil bo'lgan ko'phad Lagranj interpolatsiya ko'phadi deyiladi.

2. Lagranj usulining dasturi.

```

program lagrangeinterpolation;
type vec=array[0..20] of real;
var i,j,n:integer;  x,y,f:vec;  p,Pn,e,x0:real;
  procedure tab(n:integer;var x,y:vec);
var i:integer;
begin
  for i:=0 to n do begin
    write('x,y['i,']=') ; readln(x[i],y[i]);
  end;
end;
procedure lagrang(n:integer;x,f:vec; x0:real; var Pn:real);
var l1,l2:real;i,j:integer;
begin
  Pn:=0;
  for i:=0 to n do begin l1:=1; l2:=1;
  for j:=0 to n do if i<>j then begin l1:=l1*(x0-x[j]);l2:=l2*(x[i]-x[j]); end;
  Pn:=Pn+y[i]*l1/l2;
end;
end;
begin
write('n='); readln(n); tab(n,x,y);
repeat
write('x0='); readln(x0);
  for i:=0 to n do f[i]:=y[i]; lagrang(n,x,f,x0,Pn);  writeln('Pn('x0,')='Pn);
until false;
end.

```

Dastur asosida tajriba o'tkazamiz: n=4

```

x,y[0]=0 1
x,y[1]=1 2
x,y[2]=3 1
x,y[3]=2 3
x,y[4]=4 2
x0=0 Pn(0)=1
x0=1 Pn(1)=2
x0=2 Pn(2)=3
x0=3 Pn(3)=1

```

$$x_0=4 \quad P_n(4)=2$$

Natija dasturni to'rtligini ko'rsatadi.

Laboratoriya ishi №7.

JADVAL KURINISHIDA BERILGAN FUNKTSIYALARNI ANALITIK KURINISHDA IFODALASH

Vazifa: Jadval kurinishida berilgan funktsiyalarni eng kichik kvadratlar usuli bilan analitik kurinishda ifodalang. Algoritmini tuzib, dasturlash tilida dastur kodini yozing va natija oling.

Laboratoriya ishiga doir variantlar:

1		2		3	
X	Y	Y	X	Y	X
0.43	1.63597	0.702	0.02	1.02316	0.102
0.48	1.73234	0.512	0.08	1.09590	0.114
0.55	1.87686	0.645	0.12	1.14725	0.125
0.62	2.03345	0.736	0.17	1.21483	0.203
0.70	2.22846	0.608	0.23	1.30120	0.154
0.75	2.35973	0.646	0.30	1.40976	0.167

4		5		6	
X	Y	Y	X	Y	X
0.35	2.73951	0.526	0.41	2.57418	0.616
0.41	2.30080	0.453	0.46	2.32513	0.478
0.47	1.96864	0.482	0.52	2.09336	0.665
0.51	1.78776	0.552	0.60	1.86203	0.537
0.56	1.59502	0.436	0.65	1.74926	0.673
0.64	1.34310	0.378	0.72	1.62098	0.545

7		8		9	
X	Y	Y	X	Y	X
0.68	0.80.866	0.896	0.11	9.05421	0.314
0.73	0.89492	0.812	0.15	6.61659	0.235
0.80	1.02964	0.774	0.21	4.69170	0.332
0.88	1.20966	0.955	0.29	3.35106	0.275
0.93	1.34087	0.715	0.35	2.73951	0.186
0.99	1.52368	0.911	0.40	2.36522	0.167

10		11		12	
X	Y	Y	X	Y	X
1.375	5.04192	1.383	0.115	8.65729	0.1264
1.380	5.17744	1.392	0.120	8.29329	0.1315
1.385	5.32016	1.386	0.125	7.95829	0.1232
1.390	5.47069	1.393	0.130	7.64893	0.1334
1.395	5.62968	1.386	0.135	7.36235	0.1285
1.400	5.79788	1.356	0.140	7.09613	0.1211

13		14		15	
X	Y	Y	X	Y	X
0.150	6.61659	0.152	0.180	5.61543	0.1838
0.155	6.39989	0.161	0.185	5.46693	0.1875
0.160	6.19658	0.166	0.190	5.32634	0.1944
0.165	6.00551	0.154	0.195	5.19304	0.1976
0.170	5.82558	0.162	0.200	5.06649	0.2038
0.175	5.65583	0.146	0.205	4.94619	0.2111

16		17		18	
X	Y	Y	X	Y	X
0.210	4.83170	0.212	1.415	0.888551	1.4179
0.215	4.72261	0.216	1.420	0.889599	1.4258
0.220	4.61855	0.223	1.425	0.890637	1.4396
0.225	4.51919	0.226	1.430	0.891667	1.4236
0.230	4.42422	0.224	1.435	0.892687	1.4315
0.235	4.33337	0.186	1.440	0.893698	1.4456

Vazifani bajarish uchun kursatma:

Interpolyatsiya deganda ε kli o'zgaruvchining diskret nuq'talari bilan funktsiyaning shu nuq'talardagi mos q'iymatlari orasidagi munosabati ma'lum bo'lgan holda funktsional bo'lanishning taq'ribiy yoki aniq' analitik ifodasini tuzish tushuniladi. Ko'pincha kuzatishlar va tajribalar orq'ali empirik formulalarni keltirib chiq'arish mumkin. Eng kichik kvadratlar usulining mohiyati bilan tanishib chiq'amiz.

Funktsiya jadval ko'rinishda berilgan.

H	1	2	...	n
Y	Y_1	Y_2	...	Y_n

Bu q'iymatlarga mos nuq'talarni koordinata tekisligida tasvirlaganda hosil buladigan grafik kurinishi tugri chizikka yakin bulsa, ana shu tajriba o'tkazish natijasida hosil bulgan nuq'talardan kam farq' q'iladigan $u=ah+b$ funktsiyani ko'rishimiz mumkin (chiziq'li hol).

Umuman olganda bu funktsiya kvadratik, ya'ni $u=a^2+bx+c$ yoki $u=asin\varphi x+bcos\varphi x$ ko'rinishlarda tanlab olinishi mumkin. Tajriba nuq'talarining joylashish holatiga q'arab kerakli ko'rinishdagi funktsiyalar tanlab olinadi.

CHizmada yasalgan to'fri chiziq' bilan bir nuq'ta orasidagi masofalar ayirmasini kvadratlarining yifindisini hatolari minimum bo'lsin:

$$Z(a; b) = \sum_{i=1}^n (y_i - (ax_i + b))^2 \quad \min z = ? \quad i=1, 2, \dots, n$$

Ushbu shart bajarilishi uchun, no'malum ko'effitsentlardan olingan hususiy hosilalar nolga teng bo'lishi kerak, ya'ni $\frac{\partial z}{\partial a} = 0$; $\frac{\partial z}{\partial b} = 0$;

$$\frac{\partial z}{\partial a} = 2 \cdot \sum_{i=1}^n (y_i - (ax_i + b)) \cdot (-x_i) = 0$$

$$\frac{\partial z}{\partial b} = 2 \cdot \sum_{i=1}^n (y_i - (ax_i + b)) \cdot (-1) = 0$$

$$\begin{cases} -\sum_{i=1}^n x_i y_i + a \sum_{i=1}^n x_i^2 + b \sum_{i=1}^n x_i = 0 \\ -\sum_{i=1}^n y_i + a \sum_{i=1}^n x_i^2 + b \sum_{i=1}^n x_i = 0 \\ \left\{ \begin{array}{l} a \sum_{i=1}^n x_i y_i + b \sum_{i=1}^n x_i = \sum_{i=1}^n x_i y_i \\ a \sum_{i=1}^n x_i + b \cdot n = \sum_{i=1}^n y_i \end{array} \right. \end{cases} \quad (1)$$

kerakli belgilashlarni kiritib,

$$\begin{cases} c_{11}a + c_{12}b = p_1 \\ c_{21}a + c_{22}b = p_2 \end{cases}$$

tenglamalar sistemasini hosil q'ilamiz. Bunda:

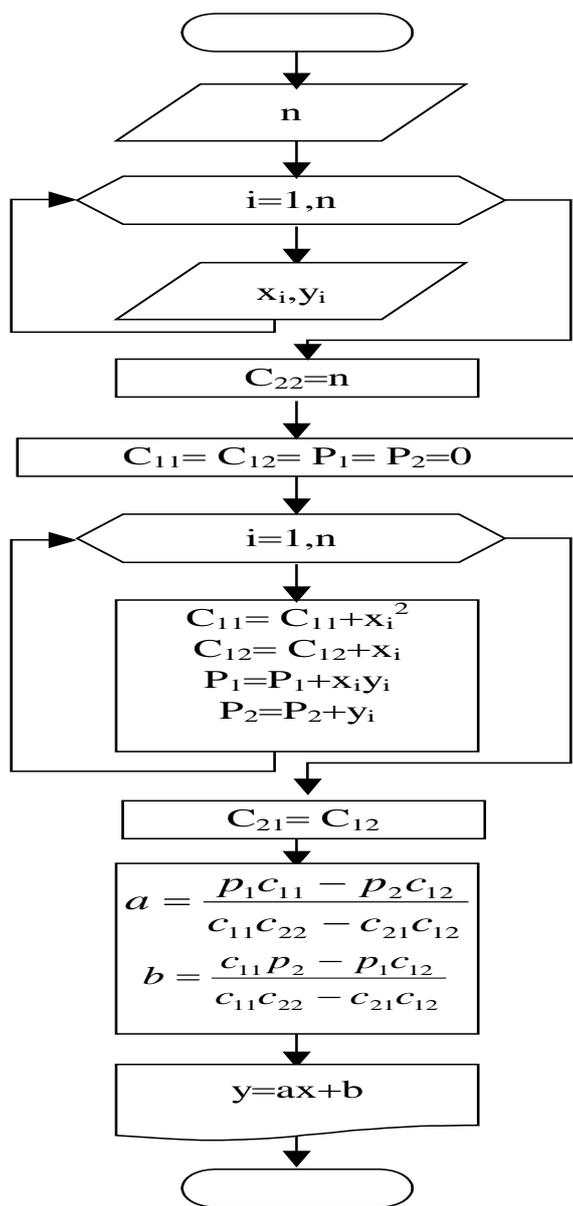
$$c_{11} = \sum_{i=1}^n x_i^2, \quad c_{12} = \sum_{i=1}^n x_i, \quad p_1 = \sum_{i=1}^n x_i y_i$$

$$c_{21} = c_{12}, \quad c_{22} = n, \quad p_2 = \sum_{i=1}^n y_i$$

Ikki noma'lumli tenglamalar sistemasini Kramer usulida echimi quyidagicha buladi, ya'ni

$$a = \frac{p_1 c_{11} - p_2 c_{12}}{c_{11} c_{22} - c_{21} c_{12}} \quad b = \frac{c_{11} p_2 - p_1 c_{12}}{c_{11} c_{22} - c_{21} c_{12}}$$

(1) sistemadan **a** va **b** topilgandan so'ng $u = ah + bv$ funktsiyani ifodasini hosil q'ilamiz. Endi har q'anday argumentning q'iyamatida ham funktsiyaning q'iyamatini hisoblash mumkin bo'ladi.



Энг кичик квадратлар usulining algoritmi:

Энг кичик квадратлар usuli uchun dastur kodi:

```

Program Kvadusul;
const n=6;
var x0,y0,a,b,c11,c12,c21,c22,p1,p2:real;
    x,y:array[1..6] of real;
begin
  write('Qaysi qiymat uchun hisoblaymiz');
  readln(x0);
  write('Massiv elementlarini kiriting');
  for i:=1 to n do
    readln(x[i],y[i]);
    c11:=0; c12:=0; p1:=0; p2:=0;
  for I:=1 to n do
    begin

```

```

c11:=c11+x[I]*x[I];
c12:=c12+x[I];
p1:=p1+x[I]*y[I];
p2:=p2+y[I];
end;
a:=(p1*c11-p2*c12)/(c11*c22-c21*c12);
b:=(c11*p2-p1*c12)/(c11*c22-c21*c12);
writeln('a=',a,'b=',b);
y0:=a*x0+b;
writeln('y0=',y0);
end.

```

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