**O‘ZBEKISTON RESPUBLIKASI
OLIY VA O‘RTA MAXSUS TA’LIM VAZIRLIGI**

# “IQTISODCHILAR UCHUN MATEMATIKA”

**FANIDAN MUSTAQIL TA’LIMDAN USLUBIY KO’RSATMA**

**(Sirtqi ta’lim yo’nalishlari uchun mustaqil ta’lim)**

**TUZUVCHI: “Oliy matematika, statistika va ekonometrika” kafedrasi o’qituvchisi: ______ Xolbozorov Q.X**

**TASDIQLAYDI: “Oliy matematika, statistika va ekonometrika” kafedrasi dotsenti, f.-m.f.n.: _______ Xashimov A.R**

Uslubiy ko’rsatma “Oliy matematika, statistika va ekonometrika” kafedrasi Kengashida ko‘rib chiqilgan va tavsiya qilingan (2019 yil __ avgustdagi №__-sonli bayonnoma).

**Toshkent – 2019**

**Talabaning 1-mustaqilishi**

1. Quyidagi matritsalarning $2A+3B$ chiziqli kombinatsiyasini toping, bu yerda

$$A=\begin{pmatrix}1 & 2 & 3\\ 0 & 1 & -1\end{pmatrix},\ B=\begin{pmatrix}-2 & 3 & 0\\ 2 & 1 & 1\end{pmatrix}.$$

Yechish. $2A+3B=2\cdot\begin{pmatrix}1 & 2 & 3\\ 0 & 1 & -1\end{pmatrix}+3\cdot\begin{pmatrix}-2 & 3 & 0\\ 2 & 1 & 1\end{pmatrix}=\begin{pmatrix}2 & 4 & 6\\ 0 & 2 & -2\end{pmatrix}+$

$$+\begin{pmatrix}-6 & 9 & 0\\ 6 & 3 & 3\end{pmatrix}=\begin{pmatrix}2-6 & 4+9 & 6+0\\ 0+6 & 2+3 & -2+3\end{pmatrix}=\begin{pmatrix}-4 & 13 & 6\\ 6 & 5 & 1\end{pmatrix}.$$

2. $A=\begin{pmatrix}1 & 2 & 3\\ 1 & 0 & -1\end{pmatrix}$ va $B=\begin{pmatrix}3 & 4 & 5\\ 6 & 0 & -2\\ 7 & 1 & 8\end{pmatrix}$ matritsalar berilgan. $AB$ va $BA$ matritsalar ko‘paytmasi (agar mumkin bo‘lsa)ni toping.

Yechish. $AB=\begin{pmatrix}1 & 2 & 3\\ 1 & 0 & -1\end{pmatrix}\cdot\begin{pmatrix}3 & 4 & 5\\ 6 & 0 & -2\\ 7 & 1 & 8\end{pmatrix}=$

$$=\begin{pmatrix}1\cdot3+2\cdot6+3\cdot7 & 1\cdot4+2\cdot0+3\cdot1 & 1\cdot5+2\cdot(-2)+3\cdot8\\ 1\cdot3+0\cdot6+(-1)\cdot7 & 1\cdot4+0\cdot0+(-1)\cdot1 & 1\cdot5+0\cdot(-2)+(-1)\cdot8\end{pmatrix}=$$

$$=\begin{pmatrix}36 & 7 & 25\\ -4 & 3 & -3\end{pmatrix}.$$

3. Agar $f(x)=-2x^2+5x+9,\ A=\begin{pmatrix}1 & 2\\ 3 & 0\end{pmatrix}$ bo‘lsa, $f(A)$ matritsali ko‘phadning qiymatini toping.

Yechish. $A^2=A\cdot A=\begin{pmatrix}1 & 2\\ 3 & 0\end{pmatrix}\cdot\begin{pmatrix}1 & 2\\ 3 & 0\end{pmatrix}=\begin{pmatrix}1\cdot1+2\cdot3 & 1\cdot2+2\cdot0\\ 3\cdot1+0\cdot3 & 3\cdot2+0\cdot0\end{pmatrix}=\begin{pmatrix}7 & 2\\ 3 & 6\end{pmatrix},$

$$f(A)=-2A^2+5A+9E=-2\cdot\begin{pmatrix}7 & 2\\ 3 & 6\end{pmatrix}+5\cdot\begin{pmatrix}1 & 2\\ 3 & 0\end{pmatrix}+9\cdot\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}=$$

$$=\begin{pmatrix}-14 & -4\\ -6 & -12\end{pmatrix}+\begin{pmatrix}5 & 10\\ 15 & 0\end{pmatrix}+\begin{pmatrix}9 & 0\\ 0 & 9\end{pmatrix}=\begin{pmatrix}0 & 6\\ 9 & -3\end{pmatrix}.$$

4. Uchinchi tartibli determinantni hisoblang: $\begin{vmatrix} 3 & 2 & 1 \\ 2 & 5 & 3 \\ 3 & 4 & 2 \end{vmatrix}$.

Yechish. Determinantni birinchi satr elementlari bo‘yicha yoyib hisoblaymiz:

$$\begin{vmatrix} 3 & 2 & 1 \\ 2 & 5 & 3 \\ 3 & 4 & 2 \end{vmatrix} = 3 \cdot \begin{vmatrix} 5 & 3 \\ 4 & 2 \end{vmatrix} - 2 \cdot \begin{vmatrix} 2 & 3 \\ 3 & 2 \end{vmatrix} + 1 \cdot \begin{vmatrix} 2 & 5 \\ 3 & 4 \end{vmatrix} =$$

$$= 3 \cdot (5 \cdot 2 - 3 \cdot 4) - 2 \cdot (2 \cdot 2 - 3 \cdot 3) + 1 \cdot (2 \cdot 4 - 5 \cdot 3) =$$

$$= 3 \cdot (-2) - 2 \cdot (-5) + 1 \cdot (-7) = -3.$$

5. Uchinchi tartibli determinantni uchburchak qoidasidan foydalanib hisoblang: $\begin{vmatrix} 1 & 2 & 3 \\ -4 & 5 & -6 \\ 7 & 8 & 9 \end{vmatrix}$.

Yechish. $\begin{vmatrix} 1 & 2 & 3 \\ -4 & 5 & -6 \\ 7 & 8 & 9 \end{vmatrix} = 1 \cdot 5 \cdot 9 + 2 \cdot (-6) \cdot 7 + (-4) \cdot 3 \cdot 8 -$

$$-3 \cdot 5 \cdot 7 - (-4) \cdot 2 \cdot 9 - 1 \cdot (-6) \cdot 7 = 45 - 84 - 96 - 105 + 72 + 42 = -126.$$

6. Quyidagi determinantni Laplas formulasi bilan hisoblang:

$$\Delta = \begin{vmatrix} 2 & 1 & 3 \\ 5 & 3 & 2 \\ 1 & 4 & 3 \end{vmatrix}.$$

**Yechish.**Berilgan determinantni birinchi satr elementlari bo‘yicha yoysak

$$\Delta = \begin{vmatrix} 2 & 1 & 3 \\ 5 & 3 & 2 \\ 1 & 4 & 3 \end{vmatrix} = 2A_{11} + A_{12} + 3A_{13} = 2(-1)^{1+1} \cdot M_{11} + (-1)^{1+2} \cdot M_{12} + 3(-1)^{1+3} \cdot M_{13} =$$

$$= 2 \cdot \begin{vmatrix} 3 & 2 \\ 4 & 3 \end{vmatrix} - \begin{vmatrix} 5 & 2 \\ 1 & 3 \end{vmatrix} + 3 \cdot \begin{vmatrix} 5 & 3 \\ 1 & 4 \end{vmatrix} = 2(9-8) - (15-2) + 3(20-3) = 2 - 13 + 51 = 40.$$

7. Quyidagi chiziqli tenglamalar sistemasini Gauss-Jordan usulida yeching:

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

**Yechish.** Chiziqlitenglamalar sistemasikoeffitsiyentlaridan kengaytirilgan matritsa tuzamiz. Tenglamalar ustida bajariladigan almashtirishlar yordamida asosiy matritsani quyidagicha birlikmatritsaga keltirib javobni topamiz:

$$\left(\begin{array}{cccc|c} 1 & 1 & 2 & 3 & 1 \\ 3 & -1 & -1 & -2 & -4 \\ 2 & 3 & -1 & -1 & -6 \\ 1 & 2 & 3 & -1 & -4 \end{array}\right) \Rightarrow \left(\begin{array}{cccc|c} 1 & 1 & 2 & 3 & 1 \\ 0 & 4 & 7 & 11 & 7 \\ 0 & -1 & 5 & 7 & 8 \\ 0 & 1 & 1 & -4 & -5 \end{array}\right) \Rightarrow \left(\begin{array}{cccc|c} 1 & 1 & 2 & 3 & 1 \\ 0 & 1 & 1 & -4 & -5 \\ 0 & -1 & 5 & 7 & 8 \\ 0 & 4 & 7 & 11 & 7 \end{array}\right) \Rightarrow$$

$$\Rightarrow \left(\begin{array}{cccc|c} 1 & 0 & 1 & 7 & 6 \\ 0 & 1 & 1 & -4 & -5 \\ 0 & 0 & 6 & 3 & 3 \\ 0 & 0 & 3 & 27 & 27 \end{array}\right) \Rightarrow \left(\begin{array}{cccc|c} 1 & 0 & 1 & 7 & 6 \\ 0 & 1 & 1 & -4 & -5 \\ 0 & 0 & 1 & 9 & 9 \\ 0 & 0 & 2 & 1 & 1 \end{array}\right) \Rightarrow \left(\begin{array}{cccc|c} 1 & 0 & 0 & -2 & -3 \\ 0 & 1 & 0 & -13 & -14 \\ 0 & 0 & 1 & 9 & 9 \\ 0 & 0 & 0 & -17 & -17 \end{array}\right) \Rightarrow$$

$$\Rightarrow \left(\begin{array}{cccc|c} 1 & 0 & 0 & -2 & -3 \\ 0 & 1 & 0 & -13 & -14 \\ 0 & 0 & 1 & 9 & 9 \\ 0 & 0 & 0 & 1 & 1 \end{array}\right) \Rightarrow \left(\begin{array}{cccc|c} 1 & 0 & 0 & 0 & -1 \\ 0 & 1 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \end{array}\right)$$

8.Quyidagi masalani simpleks usul bilan yeching.

$$\begin{cases} -2x_1 + x_2 \le 2; \\ -x_1 + 2x_2 \le 7; \\ x_1 \le 3; \end{cases}$$

$$x_j \ge 0, \ (j = 1, 2)$$

$$Y = -x_1 - 2x_2 \to \min.$$

***Yechish.*** Bu chiziqli tengsizliklarni standartlashtirish uchun qo'shimcha o'zgaruvchilar kiritamiz:

$$\begin{cases} -2x_1 + x_2 + x_3 = 2; \\ -x_1 + 2x_2 + x_4 = 7; \\ x_1 + x_5 = 3; \end{cases}$$

$$x_j \ge 0, \ (j = 1, 2, ..5)$$

$$Y = -x_1 - 2x_2 \to \min.$$

| $P_b$ | $C_b$ | | -1 | -2 | 0 | 0 | 0 | a.k. |
|---|---|---|---|---|---|---|---|---|
| | | $P_0$ | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ | |
| $P_3$ | 0 | 2 | -2 | 1 | 1 | 0 | 0 | $\boxed{2}$ |
| $P_4$ | 0 | 7 | -1 | 2 | 0 | 1 | 0 | 3,5 |
| $P_5$ | 0 | 3 | 1 | 0 | 0 | 0 | 1 | - |
| $\Delta_j$ | | 0 | 1 | $\boxed{2}$ | 0 | 0 | 0 | |
| $P_2$ | -2 | 2 | -2 | 1 | 1 | 0 | 0 | - |
| $P_4$ | 0 | 3 | 3 | 0 | -2 | 1 | 0 | $\boxed{1}$ |
| $P_5$ | 0 | 3 | 1 | 0 | 0 | 0 | 1 | 3 |
| $\Delta_j$ | | -4 | $\boxed{5}$ | 0 | -2 | 0 | 0 | |
| $P_2$ | -2 | 4 | 0 | 1 | $-\frac{1}{3}$ | $\frac{2}{3}$ | 0 | - |
| $P_1$ | -1 | 1 | 1 | 0 | $-\frac{2}{3}$ | $\frac{1}{3}$ | 0 | - |
| $P_5$ | 0 | 2 | 0 | 0 | $\frac{2}{3}$ | $-\frac{1}{3}$ | 1 | 3 |
| $\Delta_j$ | | -9 | 0 | 0 | $\frac{4}{3}$ | $-\frac{5}{3}$ | 0 | |
| $P_2$ | -2 | 5 | 0 | 1 | 0 | 0,5 | 0,5 | |
| $P_1$ | -1 | 3 | 1 | 0 | 0 | 0 | 1 | |
| $P_3$ | 0 | 3 | 0 | 0 | 1 | -1,5 | 1,5 | |
| $\Delta_j$ | | -13 | 0 | 0 | 0 | -1 | -2 | |

SimpleksusulningIbosqichida bazisvektorlarsistemasiga $P_3$ vektor kiritilib $P_2$ vektor bazisdanchiqarildi, II bosqichida $P_4$bazisgakiritildi va $P_1$bazisdanchiqarildi. Simpleks jadval formulalar asosida almashtirilib borildi. III bosqichda optimal yechim topildi:

$$X_0 = (3,5,3,0,\ 0,), \qquad Y_{\min} = -13.$$

9. Quyidagi transport masalasining boshlang'ich bazis yechimini "shimoliy-g'arb burchak" usuli bilan toping.

| Ta'minotchilar | Iste'molchilar | | | | Zahira hajmi |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 3 | 5 | 7 | 11 | 100 |
| $A_2$ | 1 | 4 | 6 | 2 | 130 |
| $A_3$ | 5 | 8 | 12 | 7 | 170 |
| **Talab hajmi** | 150 | 120 | 80 | 50 | |

**Yechish:**

Masalaningshartlariniquyidagihisoblashmatrisasiko'rinishdayozamiz.

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 |
|---|---|---|---|---|
| 100 | 3 | 5 | 7 | 11 |
| 130 | 1 | 4 | 6 | 2 |
| 170 | 5 | 8 | 12 | 7 |

Bu yerda $a_i$-ta'minotchilardagi mahsulot zahirasini, $b_j$-iste'molchilarning mahsulotga bo'lgan talabini bildiradi.

Shimoliy-g'arbdagi (1;1) katakka $x_{11} = \min(100;150) = 100$ ni joylashtiramiz va 1-qatorni o'chiramiz hamda $b_1$ ni $b_1' = 150 - 100 = 50$ ga almashtiramiz. So'ngra (2;1) katakka $x_{21} = \min(130,50) = 50$ ni joylashtiramiz. Bu holda 1-ustun o'chiriladi va 2-qatordagi $a_2$ ni $a_2' = 130 - 50 = 80$ ga almashtiramiz. Keyin (2;2) katakka o'tib $x_{22} = \min(80,120) = 80$ ni yozamiz. Shunday yo'l bilan (3;2) katakka $x_{32} = \min(170,40) = 40$ ni, (3;3) katakka $\min(130,80) = 80$ ni va (3;4) katakka $\min(50,50) = 50$ ni yozamiz. Natijada rejalar matrisasini hosil qilamiz:

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 |
|---|---|---|---|---|
| 100 | 3<br>100 | 5 | 7 | 11 |
| 130 | 1<br>50 | 4<br>80 | 6 | 2 |
| 170 | 5 | 8<br>40 | 12<br>80 | 7<br>50 |

topilgan boshlang'ich bazis yechim quyidagidan iborat:

$$X = \begin{pmatrix} 100 & 0 & 0 & 0 \\ 50 & 80 & 0 & 0 \\ 0 & 40 & 80 & 50 \end{pmatrix}.$$

Tuzilgan rejaga mos keluvchi harajatni hisoblaymiz.

$$F(X)=100\cdot3+50\cdot1+80\cdot4+40\cdot8+80\cdot12+50\cdot7=2300.$$

Yuqorida berilgan transport masalasining boshlang'ich bazis yechimini "minimal harajatlar" usuli bilan toping.

**Yechish:** Masalaning shartlarini quyidagi hisoblash matrisasi ko'rinishda yozamiz.

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 |
|---|---|---|---|---|
| 100 | 3 | 5 | 7 | 11 |
| 130 | 1 | 4 | 6 | 2 |
| 170 | 5 | 8 | 12 | 7 |

So'ngra $\min\limits_{i,j} c_{ij} = c_{21} = 1$ nitopib (2;1) katakka $x_{21} = \min(130,150) = 130$ niyozamiz. 2-ta'minotchidamahsulotqolmaganiuchunikkinchiqatornio'chiramiz, $b_1$ ningqiymatiniesa $b_1' = 150 - 130 = 20$ gaalmashtiramiz. Ikkinchi qadamda qolgan harajatlar ichida eng kichigini topamiz:

$$\min_{i,j} c_{ij} = c_{11} = 3$$

bo'lgani uchun (1;1) katakka $x_{11} = \min(20,100) = 20$ ni yozamiz. Bu holda birinchi ustun ham o'chiriladi va $a_1$ ning qiymati $a_1' = 100 - 20 = 80$ ga almashadi. Shunday yo'l bilan 3-qadamga (1;2) katakka $x_{12} = 80$ ni, 4-qadamda (3;4) katakka $x_{34} = 50$ ni, 5-qadamda (3;2) katakka $x_{32} = 40$ ni va 6-qadamda (3;3) katakka $x_{33} = 80$ ni yozamiz. Natijada quyidagi rejalar matrisasiga ega bo'lamiz.

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 |
|---|---|---|---|---|
| 100 | 3<br>20 | 5<br>80 | 7 | 11 |
| 130 | 1<br>130 | 4 | 6 | 2 |
| 170 | 5 | 8<br>40 | 12<br>80 | 7<br>50 |

Buholdabazisyechimquyidagichabo'ladi.

$$X = \begin{pmatrix} 20 & 80 & 0 & 0 \\ 130 & 0 & 0 & 0 \\ 0 & 40 & 80 & 50 \end{pmatrix}.$$

Bundahambandkatakchalarsoni$n$+$m$–1=3+4–1=6 gatengbo'ldi, ya'nituzilganboshlang'ichbazisyechimxosmasbazisyechimbo'ladi. Bundayyechimtuzilayotgandayo'lharajatiinobatgaolinadi. Shusababdantuzilganrejagamoskeluvchitransportharajatiko'pincha "shimoliy-g'arbburchak" usuldagiharajatdankichikvaoptimalyechimgayaqinroqbo'ladi.

Haqiqatanham

$F(X)$=20·3+80·5+130·1+40·8+80·12+50·7=2200.

Boshlang’ichbazisyechimqurishningyanaboshqausullarihammavjud.

Masalan, “ustundagiminimalharajatlarusuli”, “qatordagiminimalharajatlar” usulivaboshqalar.

Bundayusullaryordamidatransportmasalasiningboshlang’ichbazisyechiminit opishmumkin. Odatdaoptimalyechimgayaqinbo’lganboshlanqichbazisyechimnitopishgayordambe ruvchiusullardanfoydalanganma’qul.

Tuzilganboshlang’ichbazisyechimnioptimalyechimgaaylantirishuchunpotens iallarusulidebataluvchialgoritmdanfoydalanishmumkin.

10.Quyidagitransportmasalasiningoptimalyechiminipotensiallarusulidanfoydalanibt oping.

| Ta’minotchilar | Iste’molchilar | | | | **Ta’minotchilardagimahsulotzahirasi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 3 | 5 | 7 | 11 | 100 |
| $A_2$ | 1 | 4 | 6 | 2 | 130 |
| $A_3$ | 5 | 8 | 12 | 7 | 170 |
| **Iste’molchilarningtalabi** | 150 | 120 | 80 | 50 | |

**Yechish:**Masalaningberilganlaridanfoydalanibhisoblashjadvalinituzamizvab oshlang’ichbazisrejani “minimalxarajatlar” usulidanfoydalanibtopamiz.

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 | $U_i$ |
|---|---|---|---|---|---|
| 100 | 3<br>20 | 5<br>80- θ | 7<br>[2] θ | 11<br>[-7] | $U_1 = 0$ |
| 130 | 1<br>130 | 4<br>[-1] | 6<br>[1] | 2<br>[0] | $U_2 = -2$ |
| 170 | 5<br>[1] | 8<br>40+ θ | 12<br>80- θ | 7<br>50 | $U_3 = 3$ |
| $V_j$ | $V_1 = 3$ | $V_2 = 5$ | $V_3 = 9$ | $V_4 = 4$ | θ=80 |

Topilgan boshlang’ich reja

$$X_0 = \begin{pmatrix} 20 & 80 & 0 & 0 \\ 130 & 0 & 0 & 0 \\ 0 & 40 & 80 & 50 \end{pmatrix}$$

Ushbu rejaga mos kelgan umumiy transport xarajati

$$F(X_0) = 2220.$$

Topilgan boshlang’ich bazis rejani optimallikka tekshiramiz. Buning uchun ta’minotchilarga mos ravishda $U_1, U_2, U_3$ iste’molchilarga mos ravishda

$V_1, V_2, V_3, V_4$ potensiallarni mos qo'yamiz hamda band kataklar uchun potensial tenglamalar tuzamiz:

$$U_1 + V_1 = 3; \quad U_1 + V_2 = 5; \quad U_2 + V_1 = 1;$$

$$U_3 + V_2 = 8; \quad U_3 + V_3 = 12; \quad U_3 + V_4 = 7.$$

Hosil bo'lgan sistemaning aniq bir yechimini topish uchun $U_1 = 0$ deb qabul qilamiz va qolgan potensiallarning son qiymatini topamiz.

$$U_1 = 0; \; U_2 = -2; U_3 = 3;$$

$$V_1 = 3; \; V_2 = 5; V_3 = 9; V_4 = 4.$$

Topilgan potensiallarning son qiymatini 1-jadvalning o'ng tomoni va pastiga (*m*+1 – qator va *n*+1 – ustunga) joylashtiramiz. Ushbu hisob kitoblarni jadvalning o'zida bajarsa ham bo'ladi.

Endi bo'sh katakchalarda optimallik baholarini hisoblaymiz:

$$\Delta_{13} = 9 + 0 - 7 = 2; \quad \Delta_{14} = 0 + 4 - 11 = -7;$$

$$\Delta_{22} = 5 - 2 - 4 = -1; \quad \Delta_{23} = 9 - 2 - 6 = 1;$$

$$\Delta_{24} = 4 - 2 - 2 = 0; \quad \Delta_{31} = 3 + 3 - 5 = 1.$$

Topilgan sonlarni jadvaldagi bo'sh kataklarning pastki chap burchagiga joylashtiramiz. Optimallik baholari orasida musbatlari ham bor:

$$\Delta_{13} = 2 > 0; \; \Delta_{23} = 1 > 0; \; \Delta_{31} = 1 > 0.$$

Demak, topilgan bazis reja optimal reja emas. Unda

$$\max_{\Delta_{ij} > 0} \Delta_{ij} = \max(2;1;1) = 2$$

shartni qanoatlantiruvchi $(A_1, B_3)$ katakchaga $x_{13} = \theta$ sonni kiritamiz va to'rtburchakli

$$(A_1, B_3) \to (A_3, B_3) \to (A_3, B_2) \to (A_1, B_2) \to (A_1, B_3)$$

yopiq kontur tuzamiz. $\theta$ ning son qiymatini topamiz:

$$\theta = \min(80; 80) = 80.$$

Yuqoridagi formulalar yordamida yangi $X_1$ bazis rejani aniqlaymiz. $X_1$ xos reja bo'lmasligi uchun $(A_2, B_2)$ va $(A_3, B_3)$ katakchalardan bittasini, ya'ni xarajati katta bo'lgan $(A_3, B_3)$ ni bo'sh katakchaga aytantirib, $(A_2, B_2)$ katakchadagi taqsimotni esa 0 ga teng, deb qabul qilmiz va bu katakchani band katakcha deb qaraymiz. Bu holda yangi bazis reja quyidagi ko'rinishda bo'ladi:

| $b_j$ / $a_i$ | 150 | 120 | 80 | 50 | $U_i$ |
|---|---|---|---|---|---|
| 100 | 3<br>20- θ | 5<br>0+ θ | 7<br>80 | 11<br>-7 | $U_1 = 0$ |

| | | | | | |
|---|---|---|---|---|---|
| 130 | 1<br>130 | 4<br>(-1) | 6<br>(-1) | 2<br>(0) | $U_2=-2$ |
| 170 | 5<br>(1) Θ | 8<br>120-θ | 12<br>(-2) | 7<br>50 | $U_3=3$ |
| $V_j$ | $V_1=3$ | $V_2=5$ | $V_3=7$ | $V_4=4$ | θ=20 |

Jadvaldan foydalanib band katakchalarga mos keluvchi potensial tenglamalar tuzib, potensiallarning son qiymatini topamiz:

$$U_1+V_1=3;\quad U_1+V_2=5;\quad U_1+V_3=7;$$

$$U_2+V_1=1;\quad U_3+V_2=8;\quad U_3+V_4=7.$$

$$U_1=0;\ U_2=-2; U_3=3;$$

$$V_1=3;\ V_2=5; V_3=7; V_4=4.$$

Endi bo'sh katakchalar uchun optimallik baholarini tuzamiz:

$$\Delta_{14}=0+4-11=-7;\quad \Delta_{23}=-2+7-6=-1;$$

$$\Delta_{22}=-2+5-4=-1;\quad \Delta_{31}=3+3-5=1;$$

$$\Delta_{24}=-2+4-2=0;\quad \Delta_{33}=3+7-12=-2.$$

Bundan ko'rinadiki, $(A_3,B_1)$ katakchadagi optimallik bahosi $\Delta_{31}=1>0$. Demak, $X_1$reja optimal reja emas. $(A_3,B_2)$ katakchaga $x_{31}=\theta$ ni kiritib, bazis rejani optimal rejaga yaqinlashtirish mumkin. $(A_3,B_2)$ katakchaga $\theta$ ni kiritib, uni band katakchaga aytantiramiz va

$$(A_3,B_1)\to(A_3,B_2)\to(A_1,B_2)\to(A_1,B_1)$$

to'rtburchakli yopiq kontur tuzamiz. θ ning son qiymati 20 ga teng bo'ladi. Yuqoridagi formulalar yordamida yangi $X_2$ bazis rejani aniqlaymiz.

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 | $U_i$ |
|---|---|---|---|---|---|
| 100 | 3<br>(-1) | 5<br>20 | 7<br>80 | 11<br>(-7) | $U_1=0$ |
| 130 | 1<br>130-θ | 4<br>(0) | 6<br>(0) | 2<br>(1) θ | $U_2=-1$ |
| 170 | 5<br>20+ θ | 8<br>100 | 12<br>(-2) | 7<br>50- θ | $U_3=3$ |
| $V_j$ | $V_1=2$ | $V_2=5$ | $V_3=7$ | $V_4=4$ | θ=50 |

$$X_2=\begin{pmatrix} 0 & 20 & 80 & 0 \\ 130 & 0 & 0 & 0 \\ 20 & 100 & 0 & 50 \end{pmatrix};\qquad F(X_2)=2040.$$

Yangi $X_2$ bazis rejani optimallikka tekshiramiz. Buning uchun potensiallarning son qiymatini va bo'sh kaktaklardagi optimallik baholarini jadvalning o'zida hisoblaymiz.

Jadvaldan ko'riladiki, $\Delta_{24} = 1 > 0$. Demak, $X_2$ bazis reja optimal reja bo'lmaydi. $(A_3, B_4)$ katakchaga $\theta$ sonni kiritib,

$$(A_2, B_4) \to (A_3, B_4) \to (A_3, B_1) \to (A_2, B_1)$$

yopiq kontur tuzamiz. $\theta$ ning son qiymatini topamiz.

$$\theta = \min(130; 50) = 50.$$

Yuqoridagi formuladan foydalanib yangi bazis yechimni topamiz.

| $a_i$ \ $b_j$ | 150 | 120 | 80 | 50 | $U_i$ |
|---|---|---|---|---|---|
| 100 | $^{3}$ [-1] | $^{5}$ 20 | $^{7}$ 80 | $^{11}$ [-8] | $U_1 = 0$ |
| 130 | $^{1}$ 80 | $^{4}$ [0] | $^{6}$ [0] | $^{2}$ 50 | $U_2 = -1$ |
| 170 | $^{5}$ 70 | $^{8}$ 100 | $^{12}$ [-2] | $^{7}$ [-1] | $U_3 = 3$ |
| $V_j$ | $V_1 = 2$ | $V_2 = 5$ | $V_3 = 7$ | $V_4 = 3$ | |

$$X_4 = \begin{pmatrix} 0 & 20 & 80 & 0 \\ 80 & 0 & 0 & 50 \\ 70 & 100 & 0 & 0 \end{pmatrix}; \qquad F(X_4) = 1990.$$

$X_4$ xosmas bazis yechim. Bu yechim optimal yechim bo'ladi, chunki u optimallik shartlarini qanoatlantiradi:

$$\Delta_{11} = (U_1 + V_1) - c_{11} = -1; \qquad \Delta_{23} = (U_2 + V_3) - c_{23} = 0;$$

$$\Delta_{14} = (U_1 + V_4) - c_{14} = -8; \qquad \Delta_{33} = (U_3 + V_3) - c_{33} = -2;$$

$$\Delta_{22} = (U_2 + V_2) - c_{22} = 0; \qquad \Delta_{34} = (U_3 + V_4) - c_{34} = -1.$$

Demak, $X_4 = X_{opt}$; $F_{\min} = F(X_4) = 1990.$

**Baholash mezoni.** Har bir savolga berilgan to'g'ri javob 0 balldan 5 ballgacha baholananib qo'shiladi va natijaviy baho sifatida ularninng o'rta arifmetigi olinadi.

**Har bir talaba o'z mustaqil ish topshirig'i sifatida jurnaldagi tartib nomeriga mos variantni tanlaydi**.

1-misolda $f(x)$ funksiyaning matrisaviy ko'rinishini toping.

2-misolda uchinchi tartibli determinantlarni qulay usulda hisoblang.

3-misolda chiziqli tenglamalar sistemasini Gauss - Jordan metodida yeching.

4-misolda chiziqli programmalashtirish masalasini simpleks usuli bilan yeching.

5-misolda berilgan transport masalasini "shimoliy-g'arb burchak" usuli va "minimal harajatlar" usulidan foydalanib boshlang'ich bazis yechimlarini toping hamda potensiallar usuli yordamida optimal yechimini toping.

## 1-variant

1. $f(x) = -2x^2 + 5x + 9,\ A = \begin{pmatrix} 1 & 2 \\ 3 & 0 \end{pmatrix}.$

2. $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}.$

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

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

$x_j \geq 0,\ j = 1,2,3,4.$

$F = x_1 + x_2 - x_3 + 3x_4 \rightarrow \max.$

5.

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 2 | 1 | 4 | 1 | 90 |
| $A_2$ | 2 | 3 | 3 | 2 | 55 |
| $A_3$ | 3 | 2 | 3 | 2 | 80 |
| **Talab hajmi** | 70 | 40 | 70 | 45 | |

## 2-variant

1. $f(x) = 3x^3 + x^2 + 2,\ A = \begin{pmatrix} 1 & 5 \\ 0 & -3 \end{pmatrix}.$

2. $\begin{vmatrix} a & 1 & a \\ -1 & a & 1 \\ a & -1 & a \end{vmatrix}.$

3. $\begin{cases} x_1 + 2x_2 + x_3 = 8 \\ -2x_1 + 3x_2 - 3x_3 = -5 \\ 3x_1 - 4x_2 + 5x_3 = 10 \end{cases}$

4. $\begin{cases} 3x_1 + x_2 - 2x_3 + 6x_4 + 9x_5 = 3, \\ x_1 + 2x_2 - x_3 + 2x_4 + 3x_5 = 1, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4,5.$

$F = 2x_1 - x_2 - x_3 + x_4 - 4x_5 \to \min.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | | |
|---|---|---|---|---|
| | 75 | 80 | 60 | 85 |
| 100 | 6 | 7 | 3 | 5 |
| 150 | 1 | 2 | 5 | 6 |
| 50 | 8 | 10 | 20 | 1 |

## 3-variant

1. $f(x) = 2x^3 - 3x^2 + 5, \; A = \begin{pmatrix} 1 & 2 \\ -2 & 3 \end{pmatrix}.$

2. $\begin{vmatrix} 1 & b & 1 \\ 0 & b & 0 \\ b & 0 & -b \end{vmatrix}.$

3. $\begin{cases} 3x_1 + x_2 = -9 \\ x_1 - 2x_2 - x_3 = 5 \\ 3x_1 + 44x_2 - 2x_3 = 13 \end{cases}$

4. $\begin{cases} 4x_1 + 3x_2 + 2x_3 + x_4 = 16, \\ x_2 + 2x_3 + 4x_4 + 5x_5 = 16, \end{cases}$

$x_j \ge 0, \; j = 1,2,3,4,5.$

$F = x_1 + x_2 + x_3 + x_4 + x_5 \to \min.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 120 | 160 | 120 |
| 90 | 9 | 8 | 10 |
| 85 | 11 | 12 | 8 |
| 75 | 7 | 10 | 13 |
| 150 | 12 | 7 | 10 |

## 4-variant

1. $f(x) = 3x^2 - 5x + 2,\ A = \begin{pmatrix} 1 & 2 & 0 \\ 0 & 2 & -1 \\ -2 & 1 & 4 \end{pmatrix}.$

2. $\begin{vmatrix} x^2 & x & 1 \\ y^2 & y & 1 \\ z^2 & z & 1 \end{vmatrix}.$

3. $\begin{cases} 2x_1 + 3x_2 + 2x_3 = 7, \\ 3x_1 - 5x_2 + 2x_3 = 0, \\ x_1 - 5x_2 + 3x_3 = -1. \end{cases}$

4. $\begin{cases} 2x_1 - x_2 + x_3 + 2x_4 = 6, \\ 4x_1 - 4x_2 - 6x_3 + 2x_4 = -12, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4.$

$F = 2x_1 + 4x_2 - x_3 + 3x_4 \rightarrow \max.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 400 | 380 | 120 |
| 330 | 6 | 5 | 3 |
| 270 | 5 | 9 | 8 |
| 300 | 8 | 3 | 7 |

## 5-variant

1. $f(x) = x^3 - 6x^2 + 9x + 4,\ A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & -1 \\ 0 & 1 & 4 \end{pmatrix}.$

2. $\begin{vmatrix} 1 & a & b+c \\ 1 & b & c+a \\ 1 & c & a+b \end{vmatrix}.$

3. $\begin{cases} 2x_1 + x_2 = 5, \\ x_1 + 3x_3 = 16, \\ 5x_2 - x_3 = 10. \end{cases}$

4. $\begin{cases} 2x_1 - x_2 - 4x_3 + 5x_4 = 5, \\ x_1 + x_2 + x_3 - 2x_4 = 4, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4.$

$F = x_1 - 2x_2 - 3x_3 + 11x_4 \to \min.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 300 | 300 | 220 |
| 270 | 5 | 3 | 2 |
| 290 | 1 | 6 | 7 |
| 260 | 3 | 1 | 3 |

## 6-variant

1. $f(x) = 2x^2 - 3x + 1,\ A = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}.$

2. $\begin{vmatrix} \sin^2\alpha & \cos^2\alpha & 1 \\ \sin^2\beta & \cos^2\beta & 1 \\ \sin^2\gamma & \cos^2\gamma & 1 \end{vmatrix}.$

3. $\begin{cases} x_1 + x_2 - 2x_3 = 6 \\ 2x_1 + 3x_2 - 7x_3 = 16 \\ 5x_1 + 2x_2 + x_3 = 16 \end{cases}$

4. $\begin{cases} 2x_1 + x_2 + 3x_3 + x_4 = 200, \\ -x_1 + x_2 - 3x_3 - 2x_4 = 50, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4.$

$F = 2x_1 - 4x_2 + 9x_3 + x_4 \to \max.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 450 | 450 | 450 |
| 500 | 7 | 9 | 3 |
| 370 | 3 | 7 | 9 |
| 480 | 9 | 3 | 5 |

## 7-variant

1. $f(x) = 3x^2 + 2x + 5,\ A = \begin{pmatrix} 2 & -3 \\ 0 & 4 \end{pmatrix}.$

2. $\begin{vmatrix} \sin^2\alpha & \cos^2\alpha & 1 \\ \sin^2\beta & \cos^2\beta & 1 \\ \sin^2\gamma & \cos^2\gamma & 1 \end{vmatrix}.$

3. $\begin{cases} 5x_1 + 8x_2 + x_3 = 2 \\ 3x_1 - 2x_2 + 6x_3 = -7 \\ 2x_1 + x_2 - x_3 = -5 \end{cases}$

4. $\begin{cases} x_1 + 5x_2 - 3x_3 + x_4 + 2x_5 = 15, \\ -x_1 + x_2 + 2x_3 + x_4 + x_5 = 5, \\ x_1 - 3x_2 + x_3 + x_4 - 2x_5 = 15, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4,5.$

$F = -2x_1 - 5x_2 + 6x_3 + 2x_4 - x_5 \to \max.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 240 | 240 | 240 |
| 278 | 8 | 9 | 7 |
| 192 | 7 | 8 | 9 |
| 250 | 9 | 7 | 8 |

## 8-variant

1. $f(x) = 2x^3 - x^2 + 3,\ A = \begin{pmatrix} -1 & 2 \\ -3 & 1 \end{pmatrix}.$

2. $\begin{vmatrix} a & a^2+1 & (a+1)^2 \\ b & b^2+1 & (b+1)^2 \\ c & c^2+1 & (c+1)^2 \end{vmatrix}.$

3. $\begin{cases} x_1 + 2x_2 + 3x_3 = 5 \\ 4x_1 + 5x_2 + 6x_3 = 8 \\ 7x_1 + 8x_2 = 2. \end{cases}$

4. $\begin{cases} 3x_1 + 2x_2 - 11x_3 - 12x_4 - 2x_5 = 7, \\ x_1 + x_2 - 4x_3 - 5x_4 - x_5 = 3, \\ 2x_1 + x_2 - 7x_3 - 7x_4 - 2x_5 = 4, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4,5.$

$F = -x_1 - x_2 + 7x_3 + 7x_4 - x_5 \to \min.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 180 | 360 | 360 |
| 150 | 7 | 6 | 5 |
| 180 | 5 | 7 | 6 |
| 270 | 6 | 5 | 7 |
| 300 | 7 | 8 | 9 |

## 9-variant

1. $f(x)=x^2-3x+2,\ A=\begin{pmatrix}1 & -3 & 0\\ 0 & 2 & 1\\ 3 & -3 & 2\end{pmatrix}.$

2. $\begin{vmatrix}\sin\alpha & \cos\alpha & 0\\ \sin\beta & \cos\beta & 1\\ \sin\gamma & \cos\gamma & 2\end{vmatrix}.$

3. $\begin{cases}2x_1-3x_2+x_3=-7\\ x_1+2x_2-3x_3=14\\ -x_1-x_2+5x_3=-18\end{cases}$

4. $\begin{cases}x_1-2x_2-3x_4-2x_6=12,\\ 4x_2+x_3-4x_4-3x_6=12,\\ 5x_2+5x_4+x_5+x_6=25,\end{cases}$

$x_j\geq 0,\ j=1,2,3,4,5,6.$

$F=8x_2+7x_4+x_6\to\max.$

5.

| Ta'minotchilardagi mahsulot zahirasi | Iste'molchilarning mahsulotga bo'lgan talabi | | |
|---|---|---|---|
| | 300 | 200 | 200 |
| 125 | 10 | 9 | 8 |
| 190 | 8 | 10 | 9 |
| 210 | 9 | 7 | 10 |
| 175 | 7 | 8 | 7 |

## 10-variant

1. $f(x) = 4x^3 - 2x^2 + 3x - 2,\ A = \begin{pmatrix} -2 & 3 \\ 1 & 0 \end{pmatrix}.$

2. $\begin{vmatrix} 1 & 1 & 1 \\ 2 & 3 & 3 \\ 4 & 6 & 7 \end{vmatrix}.$

3. $\begin{cases} 2x_1 + 3x_2 + 2x_3 = 7, \\ 3x_1 - 5x_2 + \ 2x_3 = 0, \\ x_1 - 5x_2 + 3x_3 = -1. \end{cases}$

4. $\begin{cases} 2x_1 + 4x_2 + x_3 + 2x_4 = 28, \\ -3x_1 + 5x_2 - 3x_4 + x_5 = 30, \\ 4x_1 - 2x_2 + 8x_4 + x_6 = 32, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4,5,6.$

$F = x_1 + 3x_2 - 5x_4 \to \max.$

5.

| **Ta'minotchilardagi mahsulot zahirasi** | **Iste'molchilarning mahsulotga bo'lgan talabi** | | |
|---|---|---|---|
| | 500 | 450 | 350 |
| 310 | 6 | 7 | 9 |
| 290 | 9 | 8 | 6 |
| 300 | 5 | 9 | 4 |
| 400 | 7 | 5 | 7 |

## 11-variant

1. $f\left(x\right)=3x^{2}+5x-2,\ A=\begin{pmatrix}2 & 3 & -3\\ 0 & 1 & 4\\ 5 & -2 & 1\end{pmatrix}.$

2. $\begin{vmatrix}11 & 11 & 22\\ 2 & 3 & 1\\ 0 & 2 & 3\end{vmatrix}.$

3. $\begin{cases}x_1+\ \ 2x_2+\ \ 3x_3=3\\ 2x_1+6x_2+\ \ 4x_3=6\\ 3x_1+10x_2+8x_3=21\end{cases}$

4. $\begin{cases}x_1+2x_2\le 1,\\ 2x_1+x_2\le 1,\end{cases}$

$x_j\ge 0,\ j=1,2.$

$F=2x_1+3x_2\to \max.$

5.

| Ta'minotchilar | Iste'molchilar | | | | Zahra hajmi |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 8 | 1 | 9 | 7 | 110 |
| $A_2$ | 4 | 6 | 2 | 12 | 190 |
| $A_3$ | 3 | 5 | 8 | 9 | 90 |
| **Talab hajmi** | 80 | 60 | 170 | 80 | |

## 12-variant

1. $f(x) = x^3 - x^2 + 5,\ A = \begin{pmatrix} 1 & 0 & 1 \\ 3 & -1 & 0 \\ 0 & 0 & 2 \end{pmatrix}.$

2. $\begin{vmatrix} \sin\alpha & \cos\alpha & 1 \\ \sin\beta & \cos\beta & 1 \\ \sin\gamma & \cos\gamma & 1 \end{vmatrix}.$

3. $\begin{cases} x_1 + 2x_2 + 3x_3 = 8 \\ 4x_1 + 5x_2 + 6x_3 = 19 \\ 7x_1 + 8x_2 = 1 \end{cases}$

4. $\begin{cases} 2x_1 + 3x_2 \le 24, \\ x_1 + 3x_2 \le 15, \\ x_2 \le 4, \end{cases}$

$x_j \ge 0,\ j = 1,2.$

$F = x_1 + 2x_2 \to \max.$

5.

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 1 | 2 | 3 | 4 | 60 |
| $A_2$ | 4 | 3 | 2 | 0 | 80 |
| $A_3$ | 0 | 2 | 2 | 1 | 100 |
| **Talab hajmi** | 40 | 60 | 80 | 60 | |

## 13-variant

1. $f(x)=2x^3-x^2+3x-2,\ A=\begin{pmatrix} 2 & -3 & 4 \\ 0 & 5 & -1 \\ -2 & -1 & 3 \end{pmatrix}.$

2. $\begin{vmatrix} 22 & 1 & -3 \\ 0 & 1 & -1 \\ 33 & -2 & 1 \end{vmatrix}.$

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

4. $\begin{cases} 2x_1+2x_2-3x_3+x_4\le 6, \\ 3x_1-3x_2+6x_3\le 15, \\ x_2-x_3+x_4\le 2, \end{cases}$

$x_j\ge 0,\ j=1,2,3,4.$

$F=-2x_1-3x_2-2x_3+x_4\to \min.$

5.

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 1 | 2 | 4 | 1 | 50 |
| $A_2$ | 2 | 3 | 1 | 5 | 30 |
| $A_3$ | 3 | 2 | 4 | 4 | 10 |
| **Talab hajmi** | 30 | 30 | 10 | 20 | |

**14-variant**

1. $f(x)=2x^2-5x+3$ $A=\begin{pmatrix}2 & 4\\ 1 & 0\end{pmatrix}$.

2. $\begin{vmatrix}2 & 0 & 3\\ 7 & 1 & 6\\ 60 & 0 & 50\end{vmatrix}$.

3. $\begin{cases}3x_1-2x_2+x_3=-10,\\ 2x_1+3x_2-4x_3=16,\\ x_1-4x_2+3x_3=-18.\end{cases}$

4. $\begin{cases}2x_1+3x_2+4x_3\le 8,\\ x_1+2x_2+x_3\le 5,\\ 6x_1+3x_2+5x_3\le 15,\end{cases}$

$x_j\ge 0,\ j=1,2,3.$

$F=7x_1+9x_2-5x_3\to \max.$

5.

| Ta'minotchilar | Iste'molchilar | | | | | Zahira hajmi |
|---|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | $B_5$ | |
| $A_1$ | 7 | 12 | 4 | 8 | 5 | 180 |
| $A_2$ | 1 | 8 | 6 | 5 | 3 | 350 |
| $A_3$ | 6 | 13 | 8 | 7 | 4 | 20 |
| **Talab hajmi** | 110 | 90 | 120 | 80 | 150 | |

## 15-variant

1. $f(x) = 3x^2 - 2x + 5,\ A = \begin{pmatrix} 1 & -2 & 3 \\ 2 & -4 & 1 \\ 3 & -5 & 2 \end{pmatrix}.$

2. $\begin{vmatrix} 33 & 0 & 22 \\ -5 & 3 & -1 \\ 6 & 0 & 3 \end{vmatrix}.$

3. $\begin{cases} 3x_1 + 2x_2 + x_3 = -8 \\ 2x_1 + 3x_2 + x_3 = -3 \\ 2x_1 + x_2 + 3x_3 = -1 \end{cases}$

4. $\begin{cases} 2x_1 - x_2 + 3x_3 \geq -2, \\ -x_1 - x_2 + x_3 \leq 4, \\ 3x_1 - 2x_2 + x_3 \geq -1, \end{cases}$

$x_j \geq 0,\ j = 1,2,3.$

$F = x_1 - 2x_2 + x_3 \to \max.$

5.

| Ta'minotchilar | Iste'molchilar | | | | Zahira hajmi |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 1 | 7 | 9 | 5 | 120 |
| $A_2$ | 4 | 2 | 6 | 8 | 230 |
| $A_3$ | 3 | 8 | 1 | 2 | 160 |
| **Talab hajmi** | 130 | 220 | 90 | 70 | |

## 16-variant

1. $f(x)=x^3-7x^2+13x-5,\ A=\begin{pmatrix}5 & 2 & -3\\ 1 & 3 & -1\\ 2 & 2 & 1\end{pmatrix}.$

2. $\begin{vmatrix}5 & 6 & 3\\ 0 & 222 & 0\\ 7 & -4 & 5\end{vmatrix}.$

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

4. $\begin{cases}-x_1-x_2\le 4,\\ x_1-2x_2\le 2,\\ x_1+x_2\le 15,\\ -2x_1+x_2\le 2,\end{cases}$

$x_j\ge 0,\ j=1,2.$

$F=-5x_1+5x_2\to \min.$

5.

| Ta'minotchilar | Iste'molchilar | | | | Zahira hajmi |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 5 | 4 | 3 | 4 | 160 |
| $A_2$ | 3 | 2 | 5 | 5 | 140 |
| $A_3$ | 1 | 6 | 3 | 2 | 60 |
| **Talab hajmi** | 80 | 100 | 80 | 100 | |

**17-variant**

1. $f(x)=x^2-2x,\ A=\begin{pmatrix}1 & 3 & 1\\ 2 & 0 & 4\\ 1 & 2 & 3\end{pmatrix}.$

2. $\begin{vmatrix}0 & 110 & 0\\ 2 & 3 & 4\\ 0 & 50 & 0\end{vmatrix}.$

3. $\begin{cases}2x_1+2x_2-x_3=4\\ 3x_2+4x_3=-5\\ x_1+x_3=-2\end{cases}$

$$\begin{cases}2x_1+3x_2-4x_3\le 1,\\ 5x_1-6x_2+x_3\le 3,\\ 4x_1+x_2-2x_3\le 2,\end{cases}$$

$x_j\ge 0,\ j=1,2,3.$

4. $F=2x_1+5x_2+4x_3\to \max.$

5.

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 4 | 2 | 3 | 1 | 70 |
| $A_2$ | 6 | 3 | 5 | 6 | 140 |
| $A_3$ | 3 | 2 | 6 | 3 | 80 |
| **Talab hajmi** | 80 | 50 | 50 | 110 | |

## 18-variant

1. $f(x)=x^2+4x,\ A=\begin{pmatrix}1 & 3 & -1\\ 2 & 1 & 2\\ 0 & 1 & 0\end{pmatrix}.$

2. $\begin{vmatrix}3 & x & 0\\ y & 1 & 0\\ 0 & 0 & z\end{vmatrix}.$

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

4. $\begin{cases}x_1+x_2+2x_3\geq -5,\\ 2x_1-3x_2+x_3\leq 3,\\ 2x_1-5x_2+6x_3\leq 5,\end{cases}$

$x_j\geq 0,\ j=1,2,3.$

$F=-x_1+3x_2+2x_3\to \min.$

5.

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 6 | 7 | 3 | 2 | 180 |
| $A_2$ | 5 | 1 | 4 | 3 | 90 |
| $A_3$ | 3 | 2 | 6 | 2 | 170 |
| **Talab hajmi** | 95 | 85 | 100 | 160 | |

## 19-variant

1. $f(x)=x^2-3x,\ A=\begin{pmatrix} 2 & 3 & -1 \\ 2 & 4 & -1 \\ 1 & 1 & 0 \end{pmatrix}.$

2. $\begin{vmatrix} 10 & 10 & 10 \\ 0 & 25 & 0 \\ 5 & 5 & 30 \end{vmatrix}.$

3. $\begin{cases} 2x_1+2x_2-x_3=5, \\ 4x_1+3x_2-x_3=8, \\ 8x_1+5x_2-3x_3=16. \end{cases}$

4. $\begin{cases} 2x_1+x_2-3x_3+6x_6=18, \\ -3x_1+2x_3+x_4-2x_6=24, \\ x_1+3x_3+x_5-4x_6=36, \end{cases}$

$x_j \geq 0,\ j=1,2,3,4,5,6.$

$F=3x_1+2x_3-6x_6 \to \max.$

**5.**

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 8 | 3 | 5 | 2 | 180 |
| $A_2$ | 4 | 1 | 6 | 7 | 140 |
| $A_3$ | 1 | 9 | 4 | 3 | 200 |
| **Talab hajmi** | 100 | 60 | 280 | 80 | |

## 20-variant

1. $f(x) = x^2 + 4x - 1,\ A = \begin{pmatrix} 1 & 2 & 3 \\ -1 & 5 & 3 \\ 7 & 5 & 4 \end{pmatrix}.$

2. $\begin{vmatrix} 33 & 5 & 10 \\ 0 & 2 & 5 \\ 33 & 0 & 0 \end{vmatrix}.$

3. $\begin{cases} 2x_1 - x_2 + 3x_3 = 3, \\ 3x_1 + 3x_2 - x_3 = 8, \\ 8x_1 + 5x_2 + x_3 = 16. \end{cases}$

4. $\begin{cases} 2x_1 - x_2 - 2x_4 + x_5 = 16, \\ 3x_1 + 2x_2 + x_3 - 3x_4 = 18, \\ -x_1 + 3x_2 + 4x_4 + x_6 = 24, \end{cases}$

$x_j \geq 0,\ j = 1,2,3,4,5,6.$

$F = 2x_1 + 3x_2 - x_4 \to \max.$

5.

| **Ta'minotchilar** | **Iste'molchilar** | | | | **Zahira hajmi** |
|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | |
| $A_1$ | 4 | 1 | 3 | 3 | 40 |
| $A_2$ | 2 | 6 | 4 | 7 | 40 |
| $A_3$ | 3 | 3 | 6 | 4 | 40 |
| **Talab hajmi** | 20 | 30 | 20 | 50 | |

**21-variant**

1. $f(x)=x^2+3x-4,\ A=\begin{pmatrix}1 & -1 & 3\\ 3 & 0 & 3\\ 7 & 8 & 4\end{pmatrix}.$

2. $\begin{vmatrix}1 & 1 & 1\\ 5 & 7 & 8\\ 25 & 49 & 64\end{vmatrix}.$

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

4. 
$$\begin{cases}-x_1+4x_2-2x_3\le 6\\ x_1+x_2+2x_3+x_4=6,\\ 2x_1-x_2+2x_3=4,\end{cases}$$
$$x_j\ge 0,\ j=1,2,3,$$
$$F=x_1+2x_2-x_3\to\max.$$

5.

| $b_j$ \ $a_i$ | 35 | 25 | 20 |
|---|---|---|---|
| 20 | 5 | 2 | 3 |
| 40 | 8 | 6 | 7 |
| 20 | 2 | 5 | 4 |

## 22-variant

1. $f\left(x\right)=x^2-4x+2,\quad A=\begin{pmatrix}1 & 0 & 0\\ -2 & 1 & 0\\ 0 & -2 & 1\end{pmatrix}.$

2. $\begin{vmatrix}3 & 2 & -1\\ -2 & 2 & 3\\ 4 & 2 & -3\end{vmatrix}.$

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

4. $$\begin{cases}5x_1+3x_2\le 90,\\ 3x_1+4x_2\le 70,\\ x_1+x_2=20,\end{cases}$$
$$x_j\ge 0,\ j=1,2,$$
$$F=16x_1+10x_2\to \min.$$

5.

| $a_i$ / $b_j$ | 60 | 60 | 60 |
|---|---|---|---|
| 50 | 5 | 7 | 6 |
| 40 | 6 | 3 | 1 |
| 90 | 1 | 9 | 11 |

**23-variant**

1. $f\left(x\right)=x^2+2x-3,\ A=\begin{pmatrix}2 & -1 & 0\\ 0 & 2 & -1\\ 0 & 0 & 2\end{pmatrix}.$

2. $\begin{vmatrix}2 & 1 & 3\\ -5 & -3 & 2\\ 1 & 4 & 3\end{vmatrix}.$

3. $\begin{cases}x_1+2x_2+3x_3=2,\\ 2x_1+x_2+2x_3=2,\\ x_1+3x_2+4x_3=-3.\end{cases}$

4. $\begin{cases}x_1+3x_2+x_3\le 14,\\ 2x_1-3x_2+2x_3\ge 4,\end{cases}$

$x_j\ge 0,\ j=1,2,3,$

$F=2x_1+2x_2+3x_3\to\max.$

5.

| $a_i$ / $b_j$ | 100 | 110 | 100 | 90 |
|---|---|---|---|---|
| 115 | 9 | 8 | 10 | 11 |
| 125 | 11 | 10 | 9 | 8 |
| 160 | 3 | 7 | 5 | 6 |

**24-variant**

1. $f\left(x\right)=x^2-2x,\ A=\begin{pmatrix}1 & -1 & 2\\ 3 & 2 & 2\\ 5 & 4 & 2\end{pmatrix}.$

2. $\begin{vmatrix}1 & -2 & 3\\ -4 & 5 & -6\\ 7 & 8 & 9\end{vmatrix}.$

3. $\begin{cases}x_1+x_2+x_3=3,\\ 2x_1-x_2+x_3=2,\\ x_1+4x_2+2x_3=5.\end{cases}$

4. $\begin{cases}-x_1+x_2-3x_3-2x_4=50,\\ 2x_1+x_2+3x_3+x_4=200,\end{cases}$

$x_j\geq 0,\ j=1,2,3,4,$

$F=-2x_1+4x_2-9x_3-x_4\to \min.$

5.

| $b_j$ \ $a_i$ | 90 | 90 | 90 | 90 |
|---|---|---|---|---|
| 100 | 2 | 7 | 9 | 10 |
| 120 | 3 | 3 | 6 | 8 |
| 140 | 4 | 2 | 7 | 4 |

**25-variant**

1. $f(x) = x^3 - 3x + 1,\ A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}.$

2. $\begin{vmatrix} 3 & 2 & -1 \\ -2 & 5 & 3 \\ 3 & 4 & -2 \end{vmatrix}.$

3. $\begin{cases} x_1 + x_2 - x_3 = -4, \\ x_1 + 2x_2 - 3x_3 = 0, \\ -2x_1 - 2x_3 = 3. \end{cases}$

4. $\begin{cases} 4x_1 + 3x_2 + 2x_3 + x_4 = 16, \\ x_2 + 2x_3 + 4x_4 + 5x_5 = 16, \end{cases}$

$x_j \geq 0,\ j = 1, 2, 3, 4, 5.$

$\mathrm{F} = x_1 + x_2 + x_3 + x_4 + x_5 \to \min.$

5.

| $b_j$ \ $a_i$ | 60 | 90 | 40 | 60 |
|---|---|---|---|---|
| 50 | 8 | 6 | 5 | 4 |
| 70 | 3 | 4 | 5 | 6 |
| 70 | 6 | 7 | 8 | 9 |
| 60 | 9 | 6 | 5 | 4 |