# BIRINCHI DARAJALI TAQQOSLAMALAR SISTEMALARI.

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| ARTICLE INFO | ABSTRACT |
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| | *Maqolada birinchi darajali taqqoslamalar sistemalari qanoatlantiradigan barcha qiymatlari topish o'rganilgan.* |

Ikki o'zgaruvchili tengsizliklar sistemasini taqqoslash, matematikada juda muhim o'rin tutadi. Bu usul, o'zgaruvchilar funksiyalari, limitlar, integrallar va koordinatalar orqali tengsizliklarini taqqoslashga asoslangan.

Bir noma'lumli har xil modulii birinchi darajali taqqoslamalr sistemasining umumiy ko'rinishi quyidagidan iborat:

$$\left.\begin{array}{l} a_1 x \equiv b_1 (\mathrm{mod}\, m_1) \\ a_2 x \equiv b_2 (\mathrm{mod}\, m_2) \\ \cdots\cdots\cdots\cdots \\ a_n x \equiv b_n (\mathrm{mod}\, m_n) \end{array}\right\}$$

Bu sistema yechimini topishning umumiy usuli quyidagicha: dastlab sistemaning birinchi taqqoslamasining $x \equiv \alpha (mod\, m_1)$ yechimi topiladi, bu yerda $\alpha - m_1$ modul bo'yicha manfiy bo'lmagan eng kichik yoki absolyut qiymati jihatidan eng kichik chegirmadan iborat, bu yechimni sonlar sinfi shaklida yozib olinadi:

$$x = m_1 t + \alpha. \qquad (2)$$

(Agar birinchi taqqoslama yechimga ega bo'lmasa, berilgan sistema ham yechimga ega bo'lmaydi).

So'ngra $x$ ning (2) dagi qiymati sistemaning ikkinchi taqqoslamasiga qo'yilib, $a_2 + (m_1 t + \alpha) \equiv b_2 (mod\, m_2)$ (3)

taqqoslama hosil qilinadi . (3) taqqoslamadan $t$ ning sonlar sinfi shaklidagi

$$t = m_2 t_1 + \beta$$

ko'rinishi topilib, u (2) tenglikka qo'yiladi va $x$ ning yangiqiymatihisoblanadi. (Agar (3) taqqoslama yechimga ega bo'lmasa, berilgan sistema ham yechimga ega bo'lmaydi).

Natijada $x$ ning sonlar sinfi shaklida yozilgan va berilgan sistemaning dastlabki ikkita taqqoslamasini qanoatlantiradigan qiymati hosil bo'ladi. $x$ ning topilgan qiymati

uchinchi taqoslamaga qo'yilib, hosil bo'lgan taqqoslama $t_1$ ga nisbatan yechiladi va $t_1$ ning sonlar sinfi shaklida yozilgan qiymati $x$ ning ifodasiga qo'yladi, so'ngra $x$ ning bu qiymati to'rtinchi taqqoslamag qo'yiladi va shu taxlitda sistemaning oxirgi taqqoslamasigacha yechiladi. *x ning oxirgi qiymati berilgan sistemaning yechimidan iborat bo'ladi.*

Berilgan sistemani yechishda dastavval har bir taqqoslamani alohida yechib, sistema quyidagi ko'rinishga keltirib olinadi:

$$\left.\begin{array}{l} a_1 x \equiv b_1 (\mathrm{mod}\, m_1) \\ a_2 x \equiv b_2 (\mathrm{mod}\, m_2) \\ \dots\dots\dots\dots\dots \\ a_n x \equiv b_n (\mathrm{mod}\, m_n) \end{array}\right\} \quad (4)$$

So'ngra yuqoridagi usul qo'llaniladi.

Agar (1) sistemaning $a_i x \equiv b_i (mod\, m_i)(i = \overline{1,n})$ taqqoslamalari uchun $(a_i, m_i) = d_i$ va $d_i|b_i$ $(a_i, m_i) = d_i$ va $d_i|b_i$ bo'lsa, u holda har bir $i$-nchi taqqoslamaning hadlarini va modulini $d_i$ ga qisqartirib, (1) sistemaga teng kuchli bo'lgan quyidagi sistema hosil qilinadi:

$$\left.\begin{array}{l} \dfrac{a_1}{d_1} x \equiv \dfrac{b_1}{d_1} (\mathrm{mod}\, \dfrac{m_1}{d_1}) \\ \dfrac{a_2}{d_2} x \equiv \dfrac{b_2}{d_2} (\mathrm{mod}\, \dfrac{m_2}{d_2}) \\ \dots\dots\dots\dots\dots\dots\dots \\ \dfrac{a_n}{d_n} x \equiv \dfrac{b_n}{d_n} (\mathrm{mod}\, \dfrac{m_n}{d_n}) \end{array}\right\} \quad (5)$$

Bu sistemaning taqqoslamalirini $x$ ga nisbatan yechib, (5) sistemaning yechimini quyidagi sistemaning yechimiga keltirish mumkin:

$$\left.\begin{array}{l} x \equiv \alpha_1 (\mathrm{mod}\, \dfrac{m_1}{d_1}) \\ x \equiv \alpha_2 (\mathrm{mod}\, \dfrac{m_2}{d_2}) \\ \dots\dots\dots\dots\dots \\ x \equiv \alpha_n (\mathrm{mod}\, \dfrac{m_n}{d_n}) \end{array}\right\} \quad (6)$$

Agar (4) sistemada $m_1, m_2,..., m_n$ modullar juft-jufti bilan o'zaro tub bo'lsa,

$i \neq j$ da $(m_i, m_j) = 1$ bo'lsa, u holda uning yechimini quyidagi formula bilan ham topish mumkin $x_0 = \dfrac{M}{m_1} y_1 \alpha_1 + \dfrac{M}{m_2} y_2 \alpha_2 + \cdots + \dfrac{M}{m_n} y_n \alpha_n$, (7)

bu yerda $M = [m_1, m_2,..., m_n]$ va $y_1, y_2,..., y_n$ lar $\dfrac{M}{m_i} y_i = 1 (mod\, m_i), i = \overline{1,n}$

taqqoslamalarning yechimlaridan iborat. Sistemaning yechimi $x \equiv x_0\ (mod\ M)$ taqqoslamadan iborat bo'ladi.

Agar $\dfrac{m_1}{d_1}, \dfrac{m_2}{d_2}, \dots, \dfrac{m_n}{d_n}$ modullar juft-jufti bilang o'zaro tub bo'lsa, Bu usul bilan (6) sistemani ham yechish mumkin.

Misol 1. Quyidagi taqqoslamalr sistemasini yeching:

$$\left. \begin{array}{l} x \equiv 13(\mathrm{mod}\,16) \\ x \equiv 3(\mathrm{mod}\,10) \\ x \equiv 9(\mathrm{mod}\,14) \end{array} \right\}$$

*Yechilishi.* Birinchi taqqoslamadan

$$x = 16t + 13$$

ni hosil qilamiz. $x$ ning bu qiymatini ikkinchi taqqoslamag qo'yamiz: $16t + 13 \equiv 3$ ($mod\ 10$), yoki $16t + 10 \equiv 0$ ($mod\ 10$), Bu yerdan $8t \equiv 0$ ($mod\ 5$), yoki $16t \equiv 0$ ($mod\ 5$) ni hosil qilamiz. Demak, $t = 5t_1$. $t = 5t_1$ ni $x = 16t + 13$ ifodaga qo'yamiz: $x = 16 \cdot 5t_1 + 13 = 80t_1 + 13$.

$x$ ning topilgan qiymatini uchinchi taqqoslamag qo'yamiz: $80t_1 + 13 \equiv 9$ ($mod\ 14$), yoki $80t_1 \equiv -4$ ($mod\ 14$), bu yerdan $80t_1 \equiv 10$ ($mod\ 14$), yoki $40t_1 \equiv 5$ ($mod\ 7$), yoki

$8t_1 \equiv 1$ ($mod\ 7$), bu yerdan $t_1 \equiv 1$ ($mod\ 7$), ya'ni, $t_1 = 7t_2 + 1$.

$t_1 = 7t_2 + 1$ ni $x = 80t_1 + 13$ ifodaga qo'yib, $x =$
$80\,(70t_2 + 1) + 13 = 560t_2 + 93$ ni hosil qilamiz. Shunday
qilib, $x \equiv 93$ (mod 560).

*Tekshirish*: 93 – 13 ayirma 16 ga bo'linadi; 93 – 13 ayirma 10 ga bo'linadi; 93 – 9 ayirma 14 ga bo'linadi.

*Eslatma.* $16t \equiv 0$ ($mod\ 10$) taqqoslamani yechishda biz $8t \equiv 0$ ($mod\ 5$) taqqoslamani hosil qildik, uning yechimi $t \equiv 0$ ($mod\ 5$), yoki $t = 5t_1$ berilgan taqqoslamaning $x = 80t_1 + 13$ yechimiga olib keldi. Ammo $16t \equiv 0$ ($mod\ 10$) taqqoslamaning ikkinchi $t \equiv 5$ ($mod\ 10$), yoki $t = 10t_1 + 5$ yechimi ham mavjud (chunki, $d = (16, 10) = 2$). Bu yechimni $x = 16t + 13$ ifodaga qo'yib,

$x = 16(10t_1 + 5) + 13 = 160t_1 + 93$ yechimni hosil qilamiz. Lekin

$93 \equiv 13$ ($mod\ 80$) bo'lganligi uchun, ya'ni 93 va 13 sonlari 80 modul bo'yicha bir sinfga tegishli bo'lganligi uchun $x$ ning bu qiymatiga mos bo'lgan yechim qaralmaydi.

Bu eslatmadan (1-misol) agar sistemaning biror taqqoslamasi yoki $t_1$ ga nisbatan biror taqqoslama $m$ modul bo'yicha $d$ ta yechimga ega bo'lsa, u holda sistemani yechimini topish uchun $d$ ta yechimga ega bo'lgan taqqoslama yechimini unga teng kuchli bo'lgan $m/d$ modul bo'yicha taqqoslama yechimi bilan almashtirish yetarlidir.

Misol 2. Taqqoslamalar sistemasini yeching:

$$\left. \begin{array}{l} 7x \equiv 3(\mathrm{mod}\,11) \\ 15x \equiv 5(\mathrm{mod}\,35) \\ 3x \equiv 2(\mathrm{mod}\,5) \end{array} \right\}$$

*Yechilishi.* Sistemaning har bir taqqoslamasini alohida yechib, bu sistemaga teng kuchli bo'lgan quyidagit sistemani hosil qilamiz:

$$\left. \begin{array}{l} x \equiv 2(\mathrm{mod}\,11) \\ x \equiv 5(\mathrm{mod}\,7) \\ x \equiv 4(\mathrm{mod}\,5) \end{array} \right\}$$

Bu sistemaning modullari juf-jufti bilan o'zaro tub sonlardan iborat bo'lganligi uchun uning yechimini (7) formula bilan topish mumkin.

$$M = [11, 7, 5] = 385, \frac{M}{m_1} = 35, \frac{M}{m_2} = 55, \frac{M}{m_3} = 77$$

sonlarni topib, quyidagi taqqoslamalarni tuzamiz:

$35u_1 \equiv 1 \ (mod \ 11), \ 55u_2 \equiv 1 \ (mod \ 7), \ 77u_3 \equiv 1 \ (mod \ 5),$

bu yerdan $u_1 = 6$, $u_2 = -1$, $u_3 = 3$ larni hosil qilamiz.

Endi (7) formuladan quyidagini hosil qilamiz:

$x_0 = 35\cdot6\cdot2 + 55\cdot(-1)\cdot5 + 77\cdot3\cdot4 = 1069 \equiv 299 \ (mod \ 385).$

Shunday qilib, $x \equiv 299 \ (mod \ 385)$.

Misol3.Taqqoslamalar sistemasini yeching:

$$\left.\begin{array}{l} 5x \equiv 7(mod 9) \\ 4x \equiv 3(mod 7) \\ 3x \equiv 8(mod 12) \end{array}\right\}$$

*Yechilishi*. Berilgan sistemaning uchinchi taqqoslamasida (3, 12) = 3, ammo 8 soni 3 ga bo'linmaydi, shuning uchun bu taqqoslama ham berilgan sistema ham yechimga ega emas.

Misol 4. Taqqoslamalar sistemasini yeching:

$$\left.\begin{array}{l} x \equiv 2(mod 3) \\ x \equiv 3(mod 2) \\ x \equiv -1(mod 6) \end{array}\right\}$$

*Yechilishi*. Sistemaning dastlabki ikkita taqqoslamasi $x \equiv -1 \ (mod \ 3)$ va

$x \equiv -1 \ (mod \ 2)$ taqqoslamalarga teng kuchli, shuning uchun ularni uchinchi taqqoslamaning natijasi bo'lganligi uchun tashlab yuborilsa bo'ladi. Shunday qilib, sistema uchinchi taqqoslamasining yechimi sistemaning ham yechimi bo'ladi, ya'ni. $x \equiv -1 \equiv 5 \ (mod \ 6)$.

Misol 5. 2, 3, 4, 5, 6 va 7 sonlariga bo'linganida mos ravishda 1, 2, 3, 4, 5 va 0 qoldiq hosil bo'ladigan sonni toping.

*Yechilishi*. Masala yuidagi taqqoslamalr sistemasiga keltiriladi:

$$\left.\begin{array}{l} x \equiv 1(mod 2) \\ x \equiv 2(mod 3) \\ x \equiv 3(mod 4) \\ x \equiv 4(mod 5) \\ x \equiv 5(mod 6) \\ x \equiv 0(mod 7) \end{array}\right\} \quad x \equiv 1 \ (mod \ 2) \text{ yoki } x \equiv 3 \ (mod \ 2)$$

taqqoslama $x \equiv 3 \ (mod \ 4)$ taqqoslamaning natijasi sifatida tashlab yuborilishi mumkin. Xuddi shunday $x \equiv 2 \ (mod \ 3)$ taqqoslama ham olinmaydi.

Shunday qilib, quyidagi sistemani hosil qilamiz:

$$\left.\begin{array}{l} x \equiv 3(mod 4) \\ x \equiv 4(mod 5) \\ x \equiv 5(mod 6) \\ x \equiv 0(mod 7) \end{array}\right\}$$

Bu sistemani yechib, $x \equiv 119 \ (mod \ 420)$ ni hosil qilamaiz.

Misol 6. Quyidagi taqqoslama yechimga ega bo'ladigan $a$ ning qiymatlarini toping:

$$\left.\begin{array}{l} x \equiv 5 (\mathrm{mod}\,18) \\ x \equiv 8 (\mathrm{mod}\,21) \\ x \equiv a (\mathrm{mod}\,35) \end{array}\right\}$$

*Yechilishi.* Birinchi taqqoslamadan $x = 18t + 5$

ni hosil qilamiz. $x$ ning bu qiymatini ikkinchi taqoslamaga qo'yib, $t$ ning qiymatini topamiz:

$18t + 5 \equiv 8$ ($mod$ 21), yoki $18t \equiv 3$ ($mod$ 21), yoki $6t \equiv 1$ ($mod$ 7),

$t \equiv 6$ ($mod$ 7). $t \equiv -1$ ($mod$ 7) ni olish qulayroq, bu yerdan $t = 7t_1 - 1$. Bu qiymatni $x$ ning ifodasiga qo'yib,

$x = 16 (7t_1 - 1) = 5 = 126t_1 - 13$.

$x$ ning hosil qilingan qiymatini sistemaning uchinchi taqqoslamaga qo'yamiz:

$126t_1 - 13 \equiv a$ ($mod$ 35), t.ye. $21t_1 \equiv a = 13$ ($mod$ 35).

$(21, 35) = 7$ bo'lganligi uchun oxirgi taqqoslama yechimga ega bo'lishi uchun

$a + 13 \equiv 0$ ($mod$ 7) taqqoslama yechimga ega bo'lishi kerak, bu yerdan

$a \equiv 1$ ($mod$ 7).

*Shunday qilib, berilgan sistema* a $\equiv$ *1 (*mod *7) bo'lganda yechimga ega.*

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