2- AMALIY MASHG'ULOT. Munosabatlar ustida amallar. Munosabatlar kompozitsiyasi. Binar munosabatlar va ularning matrisalarini toppish (4 soat)

Reja:

1. Munosabatlar haqida asosiy tushunchalar
2. Mustaqil bajarish uchun masala va topshiriqlar
   2.1. Munosabat va Ekvivalent munosabatlarga doir topshiriqlar
   2.2. Munosabatlarning aniqlanish sohasi, qiymatlar sohasi, ularni martitsalarda ifodalashga doir topshiriqlar
   2.3. Munosabatlar kompozitsiyasiga doir topshiriqlar

1.Munosabatlar haqida asosiy tushunchalar

2.1- Ta'rif 1. Ixtiyoriy A va B to'plamlarning **dekart** yoki **to'g'ri ko`paytmasi** deb, birinchi elementi $A$ to`plamga, ikkinchi elementi B to`plamga tegishli bo`lgan $(x,\ y)$ tartiblashgan juftliklardan iborat to`plamga aytiladi va quyidagicha belgilanadi: $A\times B=\{(x,\ y),\ \ x\in A,\ y\in B\}$.

Bunda x va y lar $(x,\ y)$ juftlikning **koordinatalari** yoki **komponentlari** deyiladi, demak mos ravishda x juftlikning birinchi koordinatasi, y esa juftlikning ikkinchi koordinatasi deyiladi.

2.1- Misol. Dekart ko'paytmaga misol qilib to'g'ri burchakli dekart koordinata sistemasida nuqtalar to'plamini olish mumkin, ya'ni tekislikda har bir nuqta ikkita koordinataga ega: abssissa va ordinata.

Misol 2. $A=\{a_1,a_2\}$ va $B=\{b_1,b_2,b_3\}$ to'plamlar berilgan bo'lsin. U holda

$$A\times B=\{a_1,a_2\}\times\{b_1,b_2,b_3\}=\{(a_1,b_1),(a_1,b_2),(a_1,b_3),(a_2,b_1),(a_2,b_2),(a_2,b_3)\}$$

2.2.-Ta'rif. $R=A\times B$ dekart ko`paytmaga **to`g`ri dekart ko`paytma,** $R^{-1}=B\times A$ ifodaga **teskari dekart ko`paytma** deyiladi.

Dekart ko'paytmaning xossalari:

1⁰. Dekart ko'paytma kommutativ emas:

$$A\times B\neq B\times A$$

2⁰. Dekart ko'paytma assotsiativ emas:

$$((A\times B)\times C)\neq(A\times(B\times C)).$$

2.3-Ta’rif . $P \subseteq A_1 \times A_2 \times ... \times A_n$ dekart ko’paytmaning ixtiyoriy bo’sh bo’lmagan P qism to`plamiga $A_1, A_2, ..., A_n$ to‘plamlar orasida aniqlangan n **o‘rinli munosabat** yoki n o‘rinli P **- predikat** deyiladi.

Agar $(a_1, a_2, ..., a_n) \in P$ bo`lsa, $P$ munosabat $(a_1, a_2, ..., a_n)$ elementlar uchun **rost munosabat** deyiladi va $P(a_1, a_2, ..., a_n) = 1$ bo`ladi, agar $(a_1, a_2, ..., a_n) \notin P$ bo`lsa, $P$ munosabat **yolg`on munosabat** deyiladi va $P(a_1, a_2, ..., a_n) = 0$ yoki $\overline{P}(a_1, a_2, ..., a_n)$ kabi yoziladi.

2.4-Ta’rif. Agar $P \subseteq A_1 \times A_2 \times ... \times A_n$ n o‘rinli munosabatda n=1 bo`lsa, $P$ munosabat $A_1$ to‘plamning qism to‘plami bo‘ladi va **unar munosabat** (bir o`rinli munosabat) yoki **xossa** deyiladi.

n=2 bo`lganda esa **binar munosabat (**ikki o‘rinli munosabat) yoki **moslik** deyiladi.

Agar $P \subseteq A^2$ bo`lsa, $P$ ga $A$ to`plamning elementlari orasidagi munosabat deyiladi.

2.2-Misol. Unar munosabatlarga misollar keltiramiz:

1) $A_1 = Z$ butun sonlar to’plamidan iborat bo`lsin. $P(x) \subseteq Z$ unar munosabat *P(x)=1* shart bilan aniqlansin, bunda $x$ – juft son, u holda $P$ munosabat quyidagi ko`rinishda bo`ladi: *P={...;-4;-2;0;2;4;...}.*

2) $A_1 = R$ haqiqiy sonlar to`plamidan iborat, $P \subseteq R$ munosabat *P(x)=1* shart bilan aniqlansin, bunda $x$ – irratsional son bo`lsin, u holda P munosabat quyidagi ko`rinishlarda bo`ladi:

$$P(\sqrt{2}) = P(e) = P(\pi) = 1, \qquad P(0) = P(1) = P\left(-\frac{1}{3}\right) = 0.$$

3) A_1 – barcha odamlar to`plami, $P(x) \subseteq A_1$ munosabatda x – erkak kishi bo`lsin. Javob: *P(x)*=1 bo`ladi.

4) A_1 – tekislikdagi barcha uchburchaklar to`plami bo`lsa, x – teng yomli uchburchaklar bo`lsin. Javob: *P(x)*=1 bo`ladi.

2.3-Misol. Binar munosabatlarga misollar keltiramiz:

1) $P_1 \subseteq Z \times Z$ binar munosabat *P(x,y)=1* shart bilan aniqlansin, bunda *x-y* 3 ga bo`linadigan sonlar, u holda $P$ munosabat quyidagi ko`rinishda bo`ladi:

P={(4;1);(5;2); (6;3);...}.

2) $P_2 \subseteq Z \times Z$ munosabat P(x,y)=1 shart bilan aniqlansin, bunda x+y 2 ga bo`linadigan sonlar bo`lsin, u holda P munosabat quyidagi ko`rinishlarda bo`ladi:

P={(1;1);(0;2); (5;3);...}.

3) $P_3 \subseteq R \times R$ munosabat $, P_3(x,y)=1$ shart bilan aniqlansin, bunda *x-y* ratsional son. U holda quyidagilar o`rinli:

$$P_3(1;4) = P_3\left(\sqrt{2}+2;\sqrt{2}\right) = P_3(e;e-1) = 1,$$

$$P_3\left(1;\sqrt{2}\right) = P_3(1;e) = P_3(1;\pi) = 0 .$$

$$P_3\left(\sqrt{2};\pi\right) = P_3(e;\pi) = 0$$

4) A – to‘plam elementlari kitob nashriyotlari nomlari bo‘lsin.

B - to‘plam elementlari ushbu kitoblarni sotadigan firmalar bo‘lsin, u holda P -munosabatga nashriyot va firmalar o‘rtasida tuzilgan shartnomalar to‘plami deb, ma‘no berish mumkin.

2.5-Ta’rif. Dekart ko‘paytmaning ixtiyoriy bo‘sh bo‘lmagan qism to‘plamiga **munosabat** deyiladi.

P -munosabat bo‘lsin, u holda $P \subset A \times B$ bo‘ladi. $< x,\ \mathrm{y} > \in R$ yozuv o‘rniga ko‘pincha $x\,P\,y$ yozishadi va “x element y ga nisbatan P munosabatda” deb o‘qiladi.

2.4-Misol. $A = \{1,\ 2,\ 3\}$ va $B = \{1\ ,\ \ 2\}$ bo‘lsin, u holda

$$A \times B = \{<1,1>, <1,2>, <2,1>, <2,\ 2>, <3,\ 1>, <3,\ 2>\}$$

Munosabat 1) $R_1 = \{<1,\ 1>, <3,\ 2>\}$

2) $R_2 = \{<1,\ 1>, <1,\ 2>, <2,2>\}$ ko‘rinishda bo‘lishi mumkin.

2.6-Ta’rif. $P \subseteq A \times B$ binar munosabat uchun $P^{-1} \subseteq B \times A$ **teskari munosabat** deyiladi, agar ixtiyoriy $x \in A$ va $y \in B$ elementlar uchun $P(x,y)=1$ dan $P^{-1}(y,x)=1$ kelib chiqsa.

2.7-Ta'rif . $x = y$ bo`lganda $I_A(x, y) = 1$ shart bajarilsa, $I_A \subseteq A \times A$ binar munosabatga **dioganal munosabat** yoki **ayniy munosabat** deyiladi. Ayniy munosabat uchun $I_A^{-1} = I_A$ tenglik o`rinli.

Binar munosabat, ya'ni moslik haqida alohida to'xtalib o'tamiz, chunki munosabatlar orasida eng ko'p uchraydigani bu moslikdir.

X va Y to'plamlar berilgan bo'lsin.

X va Y to'plamlar elementlarini qandaydir usul bilan mos qo'yib, tartiblangan juftliklarni hosil qilaylik. Agar har bir $x \in X$ element uchun $y \in Y$ element mos qo'yilgan bo'lsa, u holda X va Y to'plamlar o'rtasida **moslik o'rnatildi** deyiladi. Moslikni berish uchun quyidagilarni ko'rsatish zarur:

1) elementlari boshqa biror to'plam elementlari bilan mos qo'yiladigan X to'plam;

2) elementlari X to'plam elementlari bilan mos qo'yiladigan Y to'plam;

3) moslikni aniqlovchi qoida, ya'ni $R \subseteq X \times Y$ to'plam, uning elementlari moslikda qatnashuvchi barcha (x, y) juftliklardan iborat.

Shunday qilib, f moslik $f =< X, Y, R >$ to'plamlar uchligidan iborat bo'ladi, bunda $R \subseteq X \times Y$. Agar $(x, y) \in R$ bo'lsa, y element x elementga mos qo'yilgan deyiladi.

2.5-Misol. Laboratoriya xonasida 8 ta laboratoriya qurilmasi bor: $X = \{x_1, x_2, ..., x_8\}$. Laboratoriya ishini bajarish uchun 10 nafar talaba 5 ta guruhga ajralishdi: $Y = \{y_1, y_2, y_3, y_4, y_5\}$. U holda quyidagicha moslik bo'lishi mumkin:

$f = \{X, Y, (x_1, y_2), (x_2, y_1), (x_3, y_3), (x_5, y_4), (x_8, y_5)\}$, bu yerda $(x_1, x_2, ... x_8)$ - moslikning aniqlanish sohasi, $(y_1, y_2, y_3, y_4, y_5)$ - moslikning qiymatlari sohasi bo'ladi.

Moslik 4 xilda bo'ladi:

1. **Birga-bir qiymatli moslik**, bu X va Y to'plamlar elementlari orasidagi shunday moslikki, bunda X ning har bir elementiga Y ning bitta yagona elementi mos qo'yiladi. Masalan, musbat butun sonning kvadrati butun musbat sonning o'zi bilan birga-bir mos qo'yilgan.

2. **Birga-ko'p qiymatli moslik**, bunda X ning bitta elementiga Y danikkita va undan ortiq element mos qo'yilgan bo'ladi.

Masalan, X - butun musbat sonlar to'plami bo'lsin: $X = \{4,\ 9,\ 16\}$

Y - X dan olingan kvadrat ildiz bo'lsin: $Y = \{-2,\ 2,\ -3,\ 3,\ -4,\ 4\}$.

3. **Ko'pga-bir qiymatli moslik**, bunda Y to'plamning har bir elementiga X to'plamdan bir nechta qiymat mos qo'yiladi. Masalan, imtihon topshiruvchi talabalar to'plami X ga baholar to'plami Y mos qo'yiladi. Bunda har bir talaba bittadab baho oladi, lekin 1 ta baho bir nechta talabaga qo'yiladi.

4. **Ko'pga-ko'p qiymatli moslik**, bunda X to'plamning bitta elementiga Y to'plamdan bir nechta qiymat mos qo'yiladi, shuningdek, Y ning bitta elementiga X dan bir nechta qiymat mos qo'yiladi. Masalan, X - biror qurilmaning bajaruvchi sxemalari, Y - esa elementlar tipi deyish mumkin.

2.6-Misol. Odamlar o'rtasidagi "qarindoshlik" munosabati binar munosabat bo'lib, bu to'plam umumiy ajdodga ega bo'lgan odamlar juftligini o'z ichiga oladi.

Binar munosabatlar 3 xil usulda beriladi:

1. Juftliklarning (sanab o'tilgan) ro'yhati.
2. Matritsa (jadval) orqali.
3. Grafik – struktura ko'rinishida.

$T \subset A \times A$ berilgan bo'lsin, bu yerda $A = \{a_1, a_2, ..., a_n\}$. U holda, agar a va b orasida T munosabat bo'lsa, C kvadrat matritsaning i-satri va j-ustuni kesishgan joyda joylashgan q element 1 ga teng bo'ladi; aks holda $C_{ij} = 0$.

$$C_{ij} = \begin{cases} 1, \text{ если } (a_i,\ a_j) \in T \\ 0, \text{ если } (a_i,\ a_j) \notin T \end{cases}$$

2.7-Misol. $M = \{1,2,3,4,5\}$ to'plamda aniqlangan

$$T = \{(a,b) : (a-b) \text{ - juft son}\}$$

munosabat berilgan bo'lsin. Munosabatni ro'yhat va matritsa bilan bering.

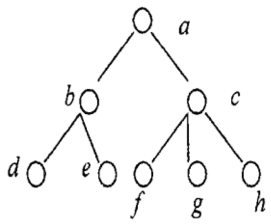
1) T = {(1, 1), (1; 3), (1, 5), (2; 2), (2; 4), (3; 1), (3; 3), (3; 5), (4; 2), (4; 4), (5; 1), (5; 3), (5; 5)}.

2) Matritsa ko'rinishi:

T	**1**	**2**	**3**	**4**	**5**
1	1	0	1	0	1
2	0	1	0	1	0
3	1	0	1	0	1
4	0	1	0	1	0
5	1	0	1	0	1

yoki $\|T\| = \begin{pmatrix} 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 \end{pmatrix}$

2.8-Misol. $M = \{a, b, c, d, e, f, g, h\}$ odamlar to'plami bo'lsin va struktura ko'rinishida berilgan bo'lsin.



Quyidagi munosabatlar haqida gapirish mumkin:

a) R_1 – "yaqin o'rtoq bo'lish" munosabati:

$$R_1 = \{(a,b),(a,c),(b,d),(b,e),(c,f),(c,g),(c,h),(b,a),$$
$$(c,a),(d,b),(e,b),(f,c),(g,c),(h,c)\}$$

$$\|R_1\| = \begin{pmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

b) R_2 – "boshliq bo'lish" munosabati:

$$R_2 = \{(a,b),(a,c),(a,d),(a,e),(a,f),(a,g),(a,h),(b,d),(b,e),(c,f),(c,g),(c,h)\}$$

c) R_3 – "ota bo'lish" munosabati:

$$R_3 = \{(a,b),(a,c),(b,d),(b,e),(c,f),(c,g),(c,h)\}.$$

2.9-Misol 10. $A=\{4,\ 5,\ 6\}$ va $B=\{1,2,3,4\}$ to'plamlar uchun $U \subseteq A\times B$ va $R \subseteq A\times B$ bo'lgan $U=\{(x,y):\ \mathrm{x+y=8}\}$, $R=\{(x,y):\ \mathrm{x<y}\}$ binar munosabatlarni tuzing.

Yechilishi: $U=\{(4,4),(5,3),(6,2)\}$ va $R=\{(x,y):\ \mathrm{x<y}\}=\varnothing$.

2. Mustaqil bajarish uchun masala va topshiriqlar

2.1. Munosabat va Ekvivalent munosabatlarga doir topshiriqlar

2.1.1. Birdan farqli natural sonlar to'plami dekart kvadratida aniqlangan R={**(*x*,*y*):** ***x*** va ***y*** lar birdan farqli umumiy bo'luvchiga ega} munosabat ekvivalent munosabat bo'ladimi?

2**.1.2.** Odamlar o'rtasidagi "yaxshi ko'rish" munosabati ekvivalent munasabat bo'ladimi?

2.1.3. Odamlar o'rtasidagi "qarindoshlik" munosabati ekvivalent munosabat bo'ladimi?

2.1.4. A={*a, b, c*} to'plam dekart kvadratida Refleksiv bo'lgan, simmetrik, tranzitiv bo'lmagan munosabatga misol keltiring va isbotlang.

2.1.5. A={*a, b, c*} to'plam dekart kvadratida simmetrik bo'lgan, refleksiv, tranzitiv bo'lmagan munosabatga misol keltiring va isbotlang.

2.1.6. A={*a, b, c*} to'plam dekart kvadratida tranzitiv bo'lgan, refleksiv, simmetrik bo'lmagan munosabatga misol keltiring va isbotlang.

2.1.7. A={*a, b, c*} to'plam dekart kvadratida refleksiv, simmetrik bo'lgan, tranzitiv bo'lmagan munosabatga misol keltiring va isbotlang.

2.1.8. A={*a, b, c*} to'plam dekart kvadratida refleksiv, tranzitiv bo'lgan, simmetrik bo'lmagan munosabatga misol keltiring va isbotlang.

2.1.9. A={*a, b, c*} to'plam dekart kvadratida simmetrik, tranzitiv bo'lgan, refleksiv bo'lmagan munosabatga misol keltiring va isbotlang.

2.1.10. A={*a, b, c*} to‘plam dekart kvadratida refleksiv, simmetrik, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.11. A={*a, b, c*} to‘plam dekart kvadratida ekvivalent munosabatga misol keltiring va isbotlang.

2.1.12. A={*a, b, c*} to‘plam dekart kvadratida refleksiv bo‘lgan, simmetrik, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.13. Kutubxonadagi kitoblar to‘plamida R munosabat quyidagicha aniqlangan: *a* va *b* kitoblar R munosabatga tegishli, agar ushbu kitoblarda bir xil adabiyotlar manbasiga murojaat qilingan bo‘lsa. R munosabat 1) Refleksiv munosabat; 2) Simmetrik munosabat; 3) Ekvivalent munosabat bo‘ladimi?

2.1.14. Internetda qidirish uchun kalit so‘zlar to‘plamida R munosabat quyidagicha aniqlansin: a va b kalit so‘zlar juftligi R munosabatga tegishli agar ular bir xil simvoldan boshlansa. R munosabat ekvivalent munosabat bo‘ladimi?

2.1.15. K-kalit so‘zlar, P- web sahifalar to‘plami bo‘lsin, R munosabat ushbu to‘plamlar dekart ko‘paytmasida aniqlangan bo‘lsin. ***(x,y)*** juftlik R munosabatga tegishli bo‘lsin, agar ***x*** kalit so‘z ***y*** web-sahifada bo‘lsa. R munosabat ekvivalent munosabat bo‘ladimi?

2.1.16. A={1,2,3,4} to‘plam dekart kvadratida Refleksiv bo‘lgan, simmetrik, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.17. A={1,2,3,4} to‘plam dekart kvadratida simmetrik bo‘lgan, refleksiv, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.18. A={1,2,3,4} to‘plam dekart kvadratida tranzitiv bo‘lgan, refleksiv, simmetrik bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.19. A={1,2,3,4} to‘plam dekart kvadratida refleksiv, simmetrik bo‘lgan, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.20. A={1,2,3,4} to‘plam dekart kvadratida refleksiv, tranzitiv bo‘lgan, simmetrik bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.21. A={1,2,3,4} to‘plam dekart kvadratida simmetrik, tranzitiv bo‘lgan, refleksiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.22. A={1,2,3,4} to‘plam dekart kvadratida refleksiv, simmetrik, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1.23. A={1,2,3,4} to‘plam dekart kvadratida ekvivalent munosabatga misol keltiring va isbotlang.

2.1.24. A={1,2,3,4} to‘plam dekart kvadratida refleksiv bo‘lgan, simmetrik, tranzitiv bo‘lmagan munosabatga misol keltiring va isbotlang.

2.1. Munosabat va Ekvivalent munosabatlarga doir topshiriq(na’muna)

2.1.0. A={1, 2, 3} to‘plamning dekart kvadratida aniqlangan R={(1,1), (2,2), (3,3), (1,2), (2,1)} munosabat ekvivalent munosabat ekanligi isbotlansin.

2.1. Topshiriqning bajarilishi bo’yicha na’muna

2.1.0. Munosabat ekvivalent bo‘lishi uchun quyidagi uchta shart bajarilishi lozim:

1. Refleksivlik sharti: $\forall x \in A$ uchun $(x, x) \in R$ (xRx) bo‘lsa;

$1 \in \mathrm{A} \Rightarrow (1,1) \in \mathrm{R}$

$2 \in \mathrm{A} \Rightarrow (2,2) \in \mathrm{R}$

$3 \in \mathrm{A} \Rightarrow (3,3) \in \mathrm{R}$

2. Simmetriklik sharti: $\forall (x, y) \in R \Rightarrow (y, x) \in R;$

$(1,2) \in \mathrm{R} \Rightarrow (2,1) \in \mathrm{R};$

$(2,1) \in \mathrm{R} \Rightarrow (1,2) \in \mathrm{R}.$

3. Tranzitivlik sharti: $(x, y) \in R, (y,z) \in R \Rightarrow (x,z) \in R.$

$(2,1) \in \mathrm{R}, (1,2) \in \mathrm{R} \Rightarrow (2,2) \in \mathrm{R}$

$(1,2) \in \mathrm{R}, (2,1) \in \mathrm{R} \Rightarrow (1,1) \in \mathrm{R}$

Demak A={1, 2, 3} to‘plamning dekart kvadratida aniqlangan R={(1,1), (2,2), (3,3), (1,2), (2,1)} munosabat ekvivalent munosabat bo‘ladi.

2.2. Munosabatlarning aniqlanish sohasi, qiymatlar sohasi, ularni martitsalarda ifodalashga doir topshiriqlar

A={a,b,c,d,e}, B={1,2,3,4} to‘plamlarda quyidagicha munosabatlar berilgan: $R_1 \subseteq A \times B$ и $R_2 \subseteq B \times B = B^2$

1) R_1, R_2 grafik ko‘rinishda ifodalansin, ularning aniqlanish va qiymatlar sohasi topilsin.

2) $R_1, R_2, R_1^{-1}, R_2^{-1}, R_2^2$, $R_2 \cap R_2^{-1}$ - munosabatlar matritsasi topilsin.

3) R_2 munosabatni refleksivlik, simmetriklik, antisimmetriklik, tranzitivlik xossalariga tekshirilsin.

2.2.1.

$R_1 = \{<a;3>, <b;1>, <b;3>, <c;2>, <c;4>, <d;3>, <e;1>, <e;2>, <e;3>, <e;4>\}$,

$R_2 = \{<1;4>, <2;1>, <2;2>, <2;3>, <3;2>, <3;3, <4;1>, <4;3>\}$.

2.2.2.

$R_1 = \{<a;1>, <a;3>, <a;4>, <d;3>, <c;1>, <c;3>, <c;4>, <d;1>, <d;3>, <e;4>\}$,

$R_2 = \{<1;1>, <1;4>, <2;1>, <2;3>, <3;2>, <4;1, <4;3>, <4;4>\}$.

2.2.3.

$R_1 = \{<a;1>, <a;3>, <b;1>, <b;3>, <c;1>, <c;3>, <d;3>, <d;4>, <e;2>, <e;4>\}$,

$R_2 = \{<1;1>, <1;2>, <1;4>, <2;3>, <3;2>, <3;4, <4;1>, <4;4>\}$.

2.2.4

$R_1 = \{<a;3>, <b;3>, <c;2>, <c;3>, <c;4>, <d;2>, <d;3>, <d;4>, <e;2>, <e;4>\}$,

$R_2 = \{<1;2>, <1;4>, <2;1>, <2;3>, <3;2>, <3;4, <4;1>, <4;3>\}$.

2.2.5.

$R_1 = \{<a;3>, <a;4>, <b;2>, <b;3>, <c;2>, <c;3>, <c;4>, <d;3>, <d;2>, <d;4>\}$,

$R_2 = \{<1;3>, <1;4>, <2;3>, <2;4>, <3;2>, <3;3, <4;1>, <4;3>\}$.

2.2.6.

$R_1 = \{<a;4>, <b;2>, <b;3>, <b;4>, <c;2>, <c;4>, <d;2>, <d;3>, <d;4>, <e;2>\}$,

$R_2 = \{<1;2>, <1;4>, <2;2>, <2;3>, <3;1>, <3;2,0 < 4;1>, <4;2>\}$.

2.2.7.

$R_1 = \{<b;1>, <b;2>, <b;3>, <c;2>, <c;4>, <d;1>, <d;2>, <d;3>, <e;2>, <e;4>\}$,

$R_2 = \{<1;1>, <1;4>, <2;1>, <2;3>, <3;1>, <3;2, <4;1>, <4;2>\}$.

2.2.8.

$R_1 = \{<b;1>, <b;2>, <b;4>, <c;1>, <c;2>, <c;4>, <d;2>, <d;3>, <e;2>, <e;3>\}$,

$R_2 = \{<1;4>, <2;3>, <2;4>, <3;2>, <3;4>, <4;1, <4;3>, <4;4>\}$.

2.2.9.

$R_1 = \{<a;3>, <b;2>, <b;3>, <c;2>, <c;4>, <d;2>, <d;4>, <e;2>, <e;3>, <e;4>\}$,

$R_2 = \{<1;3>, <1;4>, <2;2>, <2;3>, <2;4>, <3;1, <3;2>, <4;1>\}$.

2.2.10.

$R_1 = \{<a;1>, <a;3>, <b;2>, <b;4>, <c;2>, <c;3>, <d;2>, <d;4>, <e;2>, <e;3>\}$,

$R_2 = \{<1;3>, <1;4>, <2;3>, <2;4>, <3;1>, <3;2, <4;1>, <4;2>\}$.

2.2.11.

$R_1 = \{<a;1>, <a;3>, <b;2>, <c;1>, <c;2>, <c;3>, <d;2>, <e;1>, <e;2>, <e;3>\}$,

$R_2 = \{<1;1>, <1;2>, <2;1>, <2;2>, <3;3>, <3;4, <4;3>, <4;4>\}$.

2.2.12.

$$R_1 = \{< b;1 >, < b;2 >, < b;3 >, < b;4 >, < c;2 >, < d;1 >, < d;2 >, < d;3 >, < d;4 >, < e;2 >\},$$

$$R_2 = \{< 1;1 >, < 1;2 >, < 1;4 >, < 2;2 >, < 2;3 >, < 3;3, < 3;4 >, < 4;4 >\}.$$

2.2.13.

$$R_1 = \{< a;2 >, < b;1 >, < b;3 >, < b;4 >, < c;2 >, < c;4 >, < d;1 >, < d;4 >, < e;2 >, < e;4 >\},$$

$$R_2 = \{< 1;1 >, < 2;1 >, < 2;2 >, < 3;2 >, < 3;3 >, < 4;1, < 4;3 >, < 4;4 >\}.$$

2.2.14.

$$R_1 = \{< a;1 >, < a;3 >, < b;2 >, < b;4 >, < c;1 >, < c;3 >, < c;4 >, < d;4 >, < e;3 >, < e;4 >\},$$

$$R_2 = \{< 1;1 >, < 2;1 >, < 2;4 >, < 3;1 >, < 3;2 >, < 3;3, < 3;4 >, < 4;4 >\}.$$

2.2.15.

$$R_1 = \{< a;3 >, < b;1 >, < b;3 >, < c;2 >, < c;4 >, < d;3 >, < e;1 >, < e;2 >, < e;3 >, < e;4 >\},$$

$$R_2 = \{< 1;4 >, < 2;1 >, < 2;2 >, < 2;3 >, < 3;2 >, < 3;3, < 4;1 >, < 4;3 >\}.$$

2.2.16.

$$R_1 = \{< b;1 >, < b;4 >, < c;1 >, < c;2 >, < c;4 >, < d;4 >, < e;1 >, < e;2 >, < e;3 >, < e;4 >\},$$

$$R_2 = \{< 1;1 >, < 1;2 >, < 1;3 >, < 2;1 >, < 2;4 >, < 3;1, < 3;4 >, < 4;4 >\}.$$

2.2.17.

$$R_1 = \{< b;1 >, < b;2 >, < b;3 >, < b;4 >, < c;2 >, < c;4 >, < d;2 >, < d;4 >, < e;2 >, < e;4 >\},$$

$$R_2 = \{< 2;1 >, < 2;2 >, < 2;3 >, < 2;4 >, < 3;2 >, < 3;4, < 4;2 >, < 4;4 >\}.$$

2.2.18.

$$R_1 = \{< b;1 >, < b;4 >, < c;1 >, < c;4 >, < d;1 >, < d;4 >, < e;1 >, < e;2 >, < e;3 >, < e;4 >\},$$

$$R_2 = \{< 1;2 >, < 1;3 >, < 2;2 >, < 2;3 >, < 3;2 >, < 3;3, < 4;1 >, < 4;4 >\}.$$

2.2.19.

$$R_1 = \{< b;1 >, < b;2 >, < b;3 >, < b;4 >, < c;3 >, < c;4 >, < d;3 >, < d;4 >, < e;3 >, < e;4 >\},$$

$$R_2 = \{< 1;2 >, < 1;3 >, < 2;1 >, < 2;2 >, < 2;3 >, < 3;2, < 3;3 >, < 3;4 >\}.$$

2.2.20.

$$R_1 = \{< b;1 >, < b;2 >, < b;3 >, < b;4 >, < c;4 >, < d;4 >, < e;1 >, < e;2 >, < e;3 >, < e;4 >\},$$

$$R_2 = \{< 1;1 >, < 1;4 >, < 2;2 >, < 2;3 >, < 3;2 >, < 3;3, < 4;1 >, < 4;4 >\}.$$

2.2.21.

$$R_1 = \{< a;2 >, < a;3 >, < b;2 >, < b;3 >, < b;4 >, < d;1 >, < d;2 >, < d;3 >, < e;2 >, < e;3 >\},$$

$$R_2 = \{< 1;4 >, < 2;1 >, < 2;3 >, < 3;1 >, < 3;2 >, < 4;1, < 4;2 >, < 4;3 >\}.$$

2.2.22.

$$R_1 = \{< a;1 >, < a;3 >, < b;2 >, < b;3 >, < b;4 >, < d;1 >, < d;2 >, < d;3 >, < e;2 >, < e;4 >\},$$

$$R_2 = \{< 1;2 >, < 1;3 >, < 2;1 >, < 2;4 >, < 3;1 >, < 3;4, < 4;2 >, < 4;3 >\}.$$

2.2.23.

$$R_1 = \{< a;2 >, < a;3 >, < a;4 >, < c;2 >, < c;3 >, < c;4 >, < d;2 >, < d;3 >, < e;2 >, < e;3 >\},$$

$$R_2 = \{< 1;2 >, < 2;1 >, < 2;3 >, < 2;4 >, < 3;1 >, < 3;2, < 3;4 >, < 4;3 >\}.$$

2.2.24.

$$R_1 = \{< a;2 >, < a;3 >, < a;4 >, < c;1 >, < c;2 >, < c;3 >, < d;2 >, < d;4 >, < e;1 >, < e;3 >\},$$

$$R_2 = \{< 1;1 >, < 1;2 >, < 2;1 >, < 2;3 >, < 3;2 >, < 3;4, < 4;3 >, < 4;4 >\}.$$

2.2.25.

$R_1=\{<a;1>,<a;3>,<b;2>,<b;4>,<c;1>,<c;3>,<d;2>,<d;4>,<e;1>,<e;3>\}$,

$R_2=\{<1;3>,<1;4>,<2;2>,<2;4>,<3;1>,<3;2,<4;1>,<4;2>\}$.

2.2. Munosabatlarning aniqlanish sohasi, qiymatlar sohasi, ularni martitsalarda ifodalashga doir topshiriq(na'muna)

A={a,b,c,d,e}, B={1,2,3,4} to'plamlarda quyidagicha munosabatlar berilgan: $R_1 \subseteq A\times B$ и $R_2 \subseteq B\times B = B^2$

1) R_1, R_2 grafik ko'rinishda ifodalansin, ularning aniqlanish va qiymatlar sohasi topilsin.
2) $R_1, R_2, R_1^{-1}, R_2^{-1}, R_2^2$, $R_2 \cap R_2^{-1}$ - munosabatlar matritsasi topilsin.
3) R_2 munosabatni refleksivlik, simmetriklik, antisimmetriklik, tranzitivlik xossalariga tekshirilsin.

$R_1=\{<a;1>,<a;3>,<b;2>,<b;3>,<c;1>,<c;3>,<d;2>,<d;3>,<d;4>,<e;1>\}$,

$R_2=\{<1;3>,<1;4>,<2;2>,<2;3>,<2;4>,<3;2>,<3;3>,<4;4>\}$.

2.2. Topshiriqning bajarilisi bo'yicha na'muna

1) D_l(R$_1$)= {*a, b. c, d, e*} D_l(R$_2$)= {1, 2.3,4}

D_r(R$_1$)= {*1, 2. 3, 4*} D_r(R$_2$)= {*2. 3, 4*}

2) Munosabat martitsalari: $[R_1]=\begin{bmatrix}1010\\0110\\1010\\0111\\1000\end{bmatrix}$, $[R_2]=\begin{bmatrix}0011\\0111\\0110\\0001\end{bmatrix}$,

$\left[R_2^2\right]=[R_2]\times[R_2]$,

$$\left[R_2^2\right]=\begin{bmatrix}0011\\0111\\0110\\0001\end{bmatrix}\times\begin{bmatrix}0011\\0111\\0110\\0001\end{bmatrix}=\begin{bmatrix}0111\\0111\\0111\\0001\end{bmatrix},\quad \left[\mathrm{R}_1^{-1}\right]=\begin{bmatrix}10101\\01010\\11110\\00010\end{bmatrix},\quad \left[\mathrm{R}_2^{-1}\right]=\begin{bmatrix}0000\\0110\\1110\\1101\end{bmatrix},$$

$$\left[R_2\cap R_2^{-1}\right]=\begin{bmatrix}0011\\0111\\0110\\0001\end{bmatrix}\cap\begin{bmatrix}0000\\0110\\1110\\1101\end{bmatrix}=\begin{bmatrix}0000\\0110\\0110\\0001\end{bmatrix}$$

3) R_2 refleksiv emas, chunki $[R_2]\neq[E]$ *, bunda* $[E]=\begin{bmatrix}1000\\0100\\0010\\0001\end{bmatrix}$.

R_2 simmetrik emas, chunki $[R_2] \neq [R_2^{-1}]$.

R_2 antisimmetrik emas, chunki $[R_2 \cap R_2^{-1}] \not\subseteq [E]$.

R_2 tranzitiv emas, chunki $[R_2^2] \not\subseteq [R_2]$.

2.3. Munosabatlar kompozitsiyasiga doir topshiriqlar

A={a,b,c}, B={1,2,3}, C={α,β,γ} to‘plamlarda aniqlangan $R_1 \subset A \times B$ va $R_2 \subset B \times C$ binar munosabatlarning **kopaytmasi** yoki **kompozitsiyasi** topilsin:

2.3.1. R_1={(a,3),(b,2),(c,1),(c,2)}, R_2={(1,β),(2,α),(3,β), (3,γ)}

2.3.2. R_1={(a,1),(a,3),(c,1),(c,3)}, R_2={(2,α),(2,γ),(1,β), (3,α)}

2.3.3. R_1={(a,2),(b,1),(c,3)}, R_2={(1,β),(2,β), (3,α)}

2.3.4. R_1={(a,3),(b,2),(c,1)}, R_2={(1,γ),(2,α),(3,α)}

2.3.5. R_1={(a,2),(b,3),(c,1)}, R_2={(1,γ),(2,β),(3,α)}

2.3.6. R_1={(b,3),(b,2),(b,1)}, R_2={(2,γ),(2,α),(2,β)}

2.3.7. R_1={(a,1),(a,2),(a,3)}, R_2={(3,γ),(3,α),(3,β)}

2.3.8. R_1={(c,3),(c,2),(c,1)}, R_2={(1,γ),(1,α),(2,β)}

2.3.9. R_1={(c,3),(c,2),(c,1)}, R_2={(2,γ),(2,α),(2,β)}

2.3.10. R_1={(c,3),(c,2),(c,1)}, R_2={(3,γ),(3,α),(3,β)}

2.3.11. R_1={(a,3),(a,2),(a,1)}, R_2={(1,γ),(1,α),(1,β)}

2.3.15. R_1={(a,3),(a,2),(a,1)}, R_2={(2,γ),(1,α),(1,β)}

2.3.16. R_1={(a,3),(a,2),(a,1)}, R_2={(1,γ),(3,α),(1,β)}

2.3.17. R_1={(a,3),(a,2),(a,1)}, R_2={(1,γ),(1,α),(3,β)}

2.3.18. R_1={(a,3),(a,2),(a,1)}, R_2={(3,γ),(2,α),(2,β)}

2.3.19. R_1={(a,3),(a,2),(a,1)}, R_2={(2,γ),(3,α),(2,β)}

2.3.20. R_1={(a,3),(a,2),(a,1)}, R_2={(2,γ),(2,α),(3,β)}

2.3.21. R_1={(b,3),(b,2),(b,1)}, R_2={(3,β),(1,α),(1,β)}

2.3.22. R_1={(b,3),(b,2),(b,1)}, R_2={(3,β),(1,α),(1,γ)}

2.3.23. R_1={(b,3),(b,2),(b,1)}, R_2={(3,β),(1,α),(1,β)}

2.3.24. R_1={(b,3),(b,2),(b,1)}, R_2={(3,β),(2,α),(2,β)}

2.3.25. R_1={(b,3),(b,2),(b,1)}, R_2={(3,β),(2,α),(2,γ)}

2.3.12. R_1={(a,3),(a,2),(a,1)},
R_2={(2,γ),(2,α),(2,β)}

2.3.13. R_1={(b,3),(b,2),(b,1)},
R_2={(1,γ),(1,α),(1,β)}

2.3.14. R_1={(b,3),(b,2),(b,1)},
R_2={(3,γ),(3,α),(3,β)}

2.3.26. R_1={(b,3),(b,2),(b,1)},
R_2={(2,β),(2,γ),(3,α)}

2.3.27. R_1={(b,3),(b,2),(b,1)},
R_2={(3,β),(3,α),(2,γ)}

2.3.28. R_1={(b,3),(b,2),(b,1)},
R_2={(1,β),(3,α),(3,γ)}

2.3.29. R_1={(b,3),(b,2),(b,1)},
R_2={(3,β),(3,γ),(2,β)}

2.3. Munosabatlar kompozitsiyasiga doir topshiriq(na'muna)

A={*a*,*b*,*c*}, B={1,2,3}, C={α,β,γ} to'plamlarda aniqlangan $R_1 \subset A \times B$ va $R_2 \subset B \times C$ binar munosabatlarning **kopaytmasi** yoki **kompozitsiyasi** topilsin:

1.6.0. R_1={(*a*,2),(*a*,3),(*b*,1),(*c*,2)}, R_2={(1,α),(2,α),(2,β), (3,γ)}

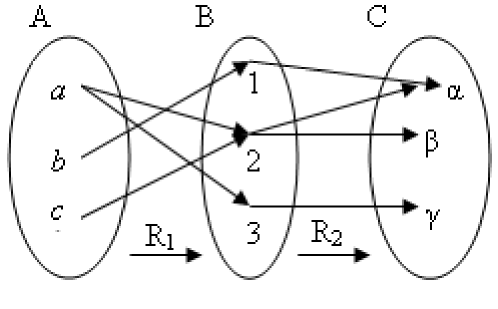
2.3. Topshiriqning bajarilishi bo'yicha na'muna

1.6.0. $R_1 \subset A \times B$ va $R_2 \subset B \times C$ binar munosabatlarning **kopaytmasi** yoki **kompozitsiyasi**,

$R_1 \circ R_2 = \{(x, \mathrm{y}) : \mathrm{x} \in \mathrm{A}, \mathrm{y} \in \mathrm{C}\ \text{ва}\ \exists \mathrm{z} \in \mathrm{B}\ \text{topiladiki}\ (\mathrm{x}, \mathrm{z}) \in \mathrm{R}_1\ \text{va}\ (\mathrm{z}, \mathrm{y}) \in \mathrm{R}_2\}$

kabi aniqlanadi, shunga ko'ra:
$R_1 \circ R_2 = \{(a,2);(a,3);(b,1);(c,2)\} \circ \{(1,\alpha);(2,\alpha);(2,\beta);(3,\gamma)\}=$
$=\{(a,\beta);(a,\alpha);(a,\gamma);(b,\alpha);(c,\alpha);(c,\beta)\}$

2-usul. R_1 va R_2 munosabatlarni quyidagicha chizmalarda ifodalab olamiz:



A to'plam elementlarini B to'plam elementlari orqali C to'plam elementlari bilan bog'lash mumkin bo'lgan yo'llarning uchlaridan iborat bo'lgan to'plamga R_1 va R_2 munosabatlarning kompozitsiyasini tashkil qiladi.