13-ma’ruza mashg`uloti

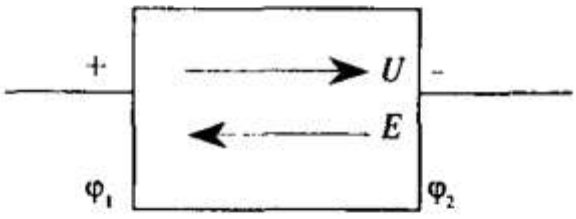
Mavzu: Berk zanjir uchun Om qonuni va Kirxgof qoidalari.

Reja:

1. **Berk zanjir uchun Om qonuni.. Elektr yurutuvchi kuch**
2. **Kirxgof qonunlari**

1. Berk zanjir uchun Om qonuni.. Elektr yurutuvchi kuch

O‘tkazgichda o‘zgarmas elektr tokini hosil qilish uchun, uning uchlarida tok manbalari yordamida uzluksiz ravishda potensiallar farqini hosil qilib turish kerak. Har qanday manba ikkita qutbga ega. Potensiali katta bo‘lgan qutb ***musbat***, potensiali kichik bo‘lgan qutb ***manfiy qutb*** deyiladi. Manba qutblari orasida potensiallar farqi (kuchlanish) mavjud. Har qanday manba qarshilikka ega, uni odatda manbaning ***ichki qarshiligi*** deyiladi. 39-rasmda tok manbaining sxematik ko‘rinishi keltirilgan (kimyo manbai, termo-element va boshqalar).



1-rasm

Manbaning musbat qutbi potensiali φ_1 va manfiy qutbning potensialini j_2 desak, unda manbaning qutblari orasidagi elektr kuchlanish:

$$U = \varphi_1 - \varphi_2$$

Manba ichidagi, ya’ni qutblar orasidagi kuchlanish, bu yerda manbaning ichki qarshiligidagi kuchlanishdir.

Manba ichida, elektr zaryadlarning harakatiga elektr kuchlanishdan qandaydir boshqa sabablar ta’siri bo‘lmaganda ichki qarshilik orqali musbat qutbdan manfiy qutbga qarab tok o‘tadi va potensiallar tenglashgunga qadar tok o‘tishi davom etadi. Ammo ulanmagan manbalarda potensiallar farqi uzoq muddat saqlanib turadi va manba ichida elektr toki bo‘lmaydi. Buni shunday tushuntirishimiz mumkin, ya’ni manba ichida elektr kuchlarining tabiatidan farqliroq tashqi kuchlar mavjud. Bunda elektr kuchlari bir birlik zaryadni musbat qutbdan manfiy qutbga ko‘chirishda bajargan ishi tashqi kuchlar bajargan ishga teng va qarama-qarshi bo‘lar ekan.

Bir birlik zaryadni tashqi kuchlar ko‘chirishida bajarilgan ish kattaligini ***elektr yurituvchi kuch*** (E.Yu.K.) deb yuritiladi.

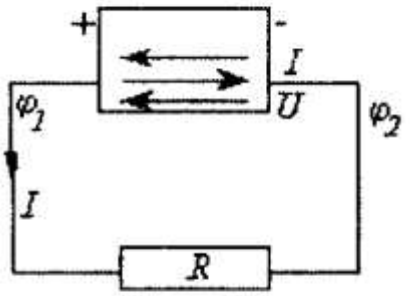
Tok manbalarini ko'pincha E.Yu.K. manbalari deb yuritiladi. E.Yu.K. ε harfi bilan belgilanadi. E.Yu.K. (ε) kuchlanish birliklarida, ya'ni voltlarda o'lchanadi. Manba ichida elektr yurituvchi kuchning ta'siri elektr kuchlanish ta'siriga qarama-qarshi yo'nalgan. Shuning uchun, E.Yu.K. manfiy qutbdan musbat qutb tomonga yo'nalgan. Ulanmagan manbada $(R=\infty)$ qutblar orasidagi elektr kuchlanish son jihatdan elektr yurituvchi kuchga teng bo'lar ekan:

$$U = \varepsilon \qquad 1.1$$

bunda, R - zanjirning tashqi qarshiligi.

Agar manbaga tashqi qarshilik ulab, yopiq zanjir hosil qilsak, unda zanjir bo'yicha tok o'tadi.

2 -rasmda ko'rsatilgan zanjirning tashqi qismida musbat zaryadning harakatini ko'rib chiqaylik. Elektr kuchlar, musbat zaryadni musbat qutbdan tashqi (R) qarshilik orqali manfiy qutbga ko'chiradi. Bu qutbdan musbat zaryad o'tganda unga elektr kuchlardan tashqari, zaryadning harakatiga to'siqlik qiluvchi tashqi kuchlar ham ta'sir qiladi.



2 *rasm.*

Zanjirda elektr toki bo'lganda, manbaning elektr yurituvchi kuchi, qutblar orasidagi kuchlanishdan katta bo'ladi. Bunda manba ichidagi tok, elektr yurituvchi kuch va kuchlanish farqining ta'siri hisobida hosil bo'ladi. Shuning uchun manba ichidagi tok Om qonuniga asosan quyidagi formula bilan aniqlanadi:

$$I = \frac{E-U}{r} \qquad 1.2$$

Zanjirning tashqi qismida esa tok kuchi:

$$I = \frac{U}{R} \qquad 1.3$$

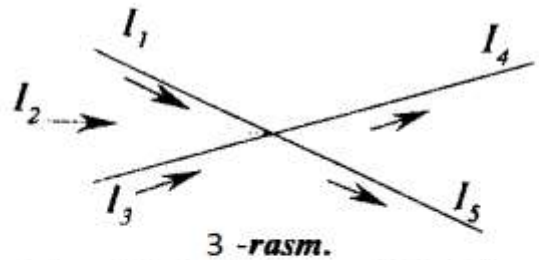
1.2 va 1.3 tenglamalardan quyidagi formulani hosil qilamiz:

$$I = \frac{E}{R+r} \qquad 1.4$$

1.4 formula berk zanjir uchun Om qonunini ifodalaydi va quyidagicha ta'riflanadi: berk zanjirdagi tok kuchi kattaligi shu zanjirdagi elektr yurituvchi kuchning kattaligiga to'g'ri proporsional va zanjirning tashqi va ichki qarshiliklari yig'indisiga teskari proporsional.

2.Kirxgof qoidalari

Elektr zanjir tok manbalari va o'tkazgichlar majmuasidan tashkil topadi. Umumiy holatda elektr zanjir tarmoqlanmagan (murakkab) bo'lsa, unda tugunlar mavjud bo'ladi. Tarmoqlangan zanjirda



3 -*rasm.*

rasm) kamida ikkita o'tkazgich birlashadigan nuqtaga tugun deb aytiladi.

Eng sodda elektr zanjirlarida tok kuchini hisoblashda Om qonunidan foydalaniladi.

Murakkab elektr zanjirlarida tokni hisoblashda Kirxgof qonunlari qo'llaniladi.

Kirxgofning birinchi qonuni tarmoqlanish tuguniga (nuqtaga) kirayotgan toklar va tugundan chiqayotgan toklar o'rtasida bog'lanishni aniqlaydi. Tarmoqlanish nuqtasi o'lchamga ega emas. Shuning uchun unda zaryad miqdori to'planmaydi.

Zaryadlarning saqlanish qonuniga asosan quyidagi xulosa kelib chiqadi: tarmoqlanish tuguniga (nuqtasiga) kirayotgan toklar yig'indisi, shu tugundan chiqayotgan toklar yig'indisiga teng. Kirxgofning I qonunini quyidagicha ta'riflashimiz ham mumkin: *har qanday zanjirning tarmoqlanish tugunida (nuqtasida) toklarning algebraik yig'indisi nolga teng.*

Agar tarmoqlanish tuguniga (nuqtaga) kirayotgan tok kuchini musbat, undan chiqayotgan tok kuchini manfiy deb qabul qilsak, unda zanjir uchun quyidagi munosabatni yozamiz:

$$I_1 + I_2 + I_3 - I_4 - I_5 = 0 \qquad 2.1$$

n ta o'tkazgichni birlashtiruvchi ixtiyoriy tarmoqlanish tuguni (nuqtasi) uchun Kirxgofning birinchi qonuni quyidagi ko'rinishda yoziladi:

$$\sum_{k=1}^{n} I_k = 0 \qquad 2.2$$

Kirxgofning ikkinchi qonunini umumiy ko'rinishda *energiyaning saqlanish qonunidan* keltirib chiqarishimiz mumkin.

Energiyaning saqlanish qonuni quyidagicha ta'riflanadi: ya'ni *izolyatsiyalangan sistemaning barcha energiyalari o'zgarishi yig'indisi nolga teng:*

$$\sum_{i} W_i = 0 \qquad 2.3$$

Agar energiyaning (har bir tarkibiy qismi uchun) o'zgarishi bajarilgan ishga teng bo'lsa,

$$\Delta A = \Delta W_i \qquad 2.4$$

unda izolyatsiyalangan sistemada barcha ishlarning algebraik yig'indisi nolga teng bo'ladi:

$$\sum_i \Delta A_i = 0 \qquad 2.4a$$

Agar tok manbalarini elektr zanjir o'tkazgichlarini va atrof muhitni izolyatsiyalangan sistema deb qabul qilsak, unda energiyaning saqlanish qonuniga asosan har qanday elektr zanjirda maydon bajarayotgan ishlar va unga qarshi bajarilayotgan ishlar yig'indisi nolga teng bo'ladi.

O'zgarmas tokda elektr zanjir bo'yicha birlik zaryadni ko'chirishda bajarilgan ish kuchlanishning har xil tabiati bilan aniqlanadi. Shuning uchun, Kirxgof qonunini quyidagicha ta'riflashimiz mumkin: *o'zgarmas tok elektr zanjirlarida har xil tabiatli maydon kuchlanishlarining algebraik yig'indisi nolga teng bo'ladi.*

Elektr zanjirlarida faqat elektr kuchlanish, qarshilikdagi kuchlanish va elektr yurituvchi kuch (tashqi maydon kuchlanishi) mavjud bo'ladi. Kirxgofning ikkinchi qonuni umumiy ko'rinishini quyidagicha yozishimiz mumkin:

$$\sum_{i=1}^{n} U_i + \sum_{k=1}^{n} U_k + \sum_{i=1}^{n} \varepsilon_k = 0 \qquad 2.5$$

bunda: U_i - i indeksi bilan belgilangan zanjir qismidagi kuchlanish,
U_k - qarshilikdagi kuchlanish,
ε_k - zanjir qismidagi E.Yu.K,
n - yopiq zanjirning alohida qismlari soni.

Unda yopiq konturlar uchun elektr kuchlanishlarning yig'indisi nolga teng bo'ladi:

$$\sum_i U_i = 0 \qquad 2.6$$

Yopiq konturlar uchun (2.5) quyidagi ko'rinishda yoziladi:

$$\sum_{k=1}^{n} \varepsilon_k + \sum_{k=1}^{n} U_k = 0 \qquad 2.7$$

Agar $U_k = -I_k R_k$ hisobga olsak, unda quyidagini hosil qilamiz:

$$\sum_{k=1}^{n} \varepsilon k = \sum_{k=1}^{n} I_k R_k \qquad 2.8$$

2.8 formulaga asosan, Kirxgofning ikkinchi qonuni quyidagicha ta'riflanadi:

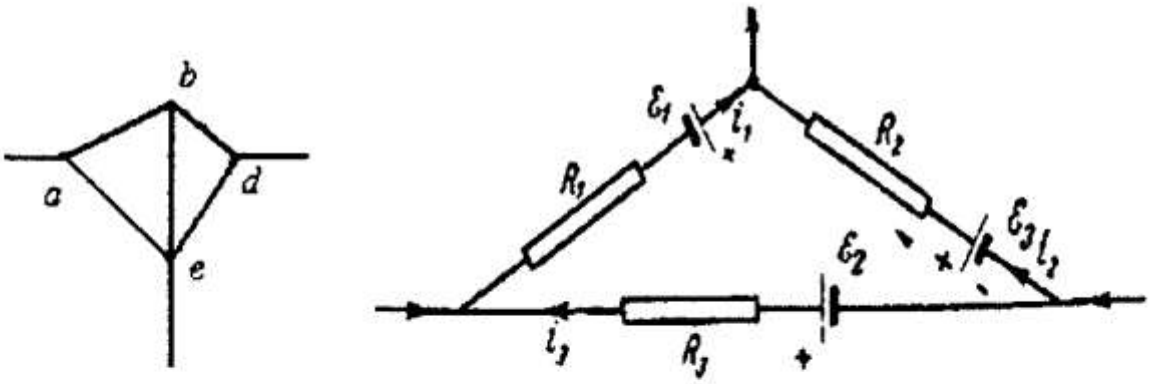
Har qanday yopiq kontur uchun elektr yurituvchi kuchlarning algebraik yig'indisi zanjir qismlarining qarshiligini undagi tok kuchiga ko'paytmasining algebraik yig'indisiga teng bo'ladi.

2.8 tenglamani tuzish uchun konturning aylanib o'tish yo'nalishini (soat strelkasi harakati bo'yicha yoki unga qarama-qarshi yo'nalishda) shartlashib olish kerak. Barcha toklar (I_k)ning yo'nalishi, konturning aylanib o'tish yo'nalishi bilan mos tushsa, unda ular musbat toklar deb hisoblanadi.

Agar ular hosil qilayotgan tok yo'nalishi konturning aylanib o'tish yo'nalishi bilan mos tushsa elektr konturning har xil qismlariga (joylariga) kiritilgan tok manbalari E.Yu.K. ($\mathcal{E}_k$) musbat deb hisoblanadi.

Masalan, 4 -rasmda ko'rsatilgan *ABDE* konturda, soat strelkasi harakati bo'yicha konturni aylanib o'tishda 2.8 tenglama quyidagi ko'rinishda yoziladi:

$$I_1 R_1 - I_2 R_2 + I_3 R_3 + I_4 R_4 = \varepsilon_1 - \varepsilon_2 + \varepsilon_3 \qquad 2.9$$



4 -rasm.

Keyingi paragraflarda masalalarni yechishda Kirxgof qonunlarining qo'llanishi keltirilgan.

TEST SAVOLLARI

1. Tugunlar uchun Kirxgof qoidasini aniqlang:

A) $\sum_i I_i R_i = \sum_k \mathcal{E}_k$ B) $I = \frac{\mathcal{E}}{r + R}$

C) $\sum_k I_k = 0$ D) $R = \sum_{i=1}^{n} R_i$

2. Kontur uchun Kirxgof qoidasini aniqlang:

A) $\sum_i I_i R_i = \sum_k \mathcal{E}_k$ B) $I = \frac{\mathcal{E}}{r + R}$

C) $\sum_k I_k = 0$ D) $R = \sum_{i=1}^{n} R_i$

3. Agar elektr zanjirining tashqi qarshiligi tok manbaining ichki qarshiligiga teng bo'lsa, tok manbaining FIK i necha foizga teng?

A) 25%. B) 35%. C) 40%. D) 75%.

4. Har bir tomoninig qarshiligi R bo'lgan teng tomonli uchburchakning ikki uchi orasidagi qarshilikni toping

A) R/2.B) 3R/2. C) 6R. D) 2R/3.

5. Tok kuchi $I = 20 + 4t$ qonun bo'yicha o'zgaradi. 2 sekundda o'kazgich orqali qancha zaryad miqdori o'tadi.

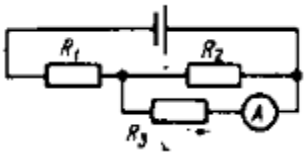
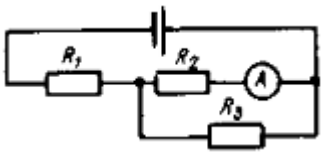
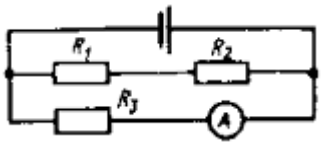
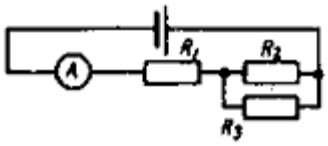
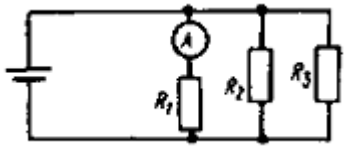
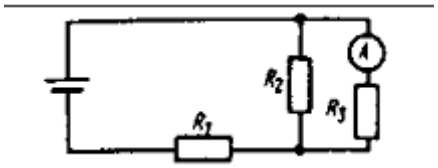
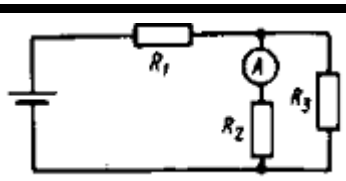
A) 20 C. B) 4 C. C) 48 C. D) 24 C.

6.O'tkazgich orqali o'tayotgan elektr zaryadi $q = 20 + 4t$ qonun bo'yicha o'zgaradi. 2 sekundda o'tkazgichdagi tok kuchini aniqlang.

A) 48A. B) 4A. C) 24. D) 20 A.

6-**AMALIY MASHG'ULOT.**
Doimiy tok qonunlari

1- masala. Elektr sxemadagi ampermetrning ko‘rsatishini aniqlang. Yopiq zanjirning uchlaridagi kuchlanish U. R_1, R_2, R_3 qarshiliklar ma’lum. Ampermetrning qarshiligini hisobga olmang.

№	Sxema	U, V	R_1, Om	R_2, Om	R_3, Om
1		2,1	5	6	3
2		3,0	7	2	3
3		4,2	6	4	6
4		2,8	3	4	9
5		4,0	4	8	12
6		12,0	10	6	8
7		20,	8	7	6
8		8,0	12	10	8
9		5,0	7	3	8
10		10,0	14	5	6
11		2,5	8	5	12
12		2,0	6	4	10
13		4,0	4	8	12
14		2,5	6	3	9
15		1,2	8	2	6
16		3,6	4	5	10
17		12,0	2	4	8
18		20,0	6	8	10
19		8,0	8	6	4
20		6,0	12	5	10
21		2,2	4	2	6
22		3,6	6	10	4
23		4,8	10	8	12
24		6,0	14	6	8
25		4,0	6	4	10
26		6,2	8	6	4
27		10,0	10	4	8
28		8,4	12	10	6

2 - masala. m massali suvni t_1 temperaturadan to qaynaguncha qizdirish uchun isitgich W elektr energiyani sarf etadi. Isitgichning F.I.K. η. Jadvaldan topshiriq raqami bo‘yicha noma’lum kattaliklarni toping.

№	*m, kg*	t_1, ^{0}S	*W*, kJ	*η, %*
1	?	30	1257	80
2	2,2	?	921,8	58
3	2,38	23	?	77
4	2	20	838	?
5	?	20	900	74,5
6	1,8	?	754,2	67
7	3,58	45	?	55
8	3	40	1250	?
9	?	25	1400	78,6
10	1,6	?	670,4	83
11	3,58	28	?	72
12	2,5	30	1047,5	?
13	?	42	1676	58
14	1,25	?	523,75	66
15	2,86	22	?	78
16	1,8	25	754,2	?
17	?	22	1257	78
18	2,3	?	963,7	81
19	2,34	26	?	74
20	1,5	0	1047,5	?
21	?	32	502,8	68
22	1,5	?	628,5	79
23	1,98	18	?	82
24	2,0	10	1676	?
25	?	27	712,3	73
26	0,8	?	335,2	84
27	1,43	10	?	60
28	0,5	12	419	?

3 - masala. E.YU.K. ε va ichki qarshiligi *r* bo‘lgan element I_{max} maksimal tok kuchi beradi. Bu element beradigan maksimal foydali quvvat P_{max}. Jadvaldan topshiriq raqami bo‘yicha noma’lum kattaliklarni toping.

№	ε, V	*r*, Om	I_{max}, A	P_{max}, Vt
1	6	?	3	?
2	4	2	?	?
3	?	2	4	?
4	4	2	?	2
5	?	?	?	8
6	10	?	2	?
7	?	5	4	6

8	2	?	?	?
9	4	1	?	2
10	?	3	4	?
11	6	?	?	?
12	?	2	2	3
13	6	?	?	?
14	?	?	6	4,5
15	8	2	4	?
16	?	?	?	4,5
17	4	4	1	?
18	8	3	?	?
19	?	?	12	?
20	6	3	?	12
21	?	?	?	3
22	6	?	3	?
23	?	2	4	2
24	10	4	?	?
25	?	?	?	1
26	?	2	3	4,5
27	?	?	8	?
28	6	?	?	9

4 - *masala.* $t=0\ ^0S$ temperaturada R_0 qarshilikka ega bo‘lgan simdan yasalgan reostat, R_A ichki qarshilikli milliampermetr va qarshiligini hisobga olmasa ham bo‘ladigan tok generatori ketma-ket ulangan. $0\ ^0S$ temperaturada milliamper I_0 tokni ko‘rsatadi. Agar reostat Δt temperaturagacha qizisa,milliamper I_1 tokni ko‘rsatadi. Resotat simining temperatura koeffitsenti α. Jadvaldan topshiriq raqami bo‘yicha noma’lum kattaliklarni toping.

№	R_0, Om	R_A, Om	I_0, mA	Δt, K	I_1, mA	a, 1/K
1	?	5	10	100	9,2	$5*10^{-3}$
2	100	?	31	80	22	$6*10^{-3}$
3	120	20	?	50	20	$6*10^{-3}$
4	80	4	102	?	95	$7*10^{-3}$
5	80	5	25	60	?	$5*10^{-3}$
6	120	8	83	16,4	76	?
7	?	4	132	40	120	$6*10^{-3}$
8	60	?	20	80	18	$2*10^{-3}$
9	90	2	?	50	102	$7*10^{-3}$
10	80	6	84	?	75	$2*10^{-3}$
11	120	20	22	50	?	$6*10^{-3}$
12	60	10	58	40	51	?
13	?	12	36	100	31	$5*10^{-3}$

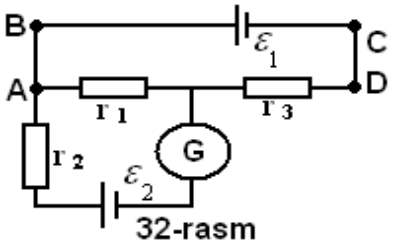
14	80	?	59	70	42	$6*10^{-3}$
15	75	10	?	50	78	$2*10^{-3}$
16	150	20	44	?	39	$5*10^{-3}$
17	130	10	120	80	?	$2*10^{-3}$
18	80	3	52	31,4	44	?
19	?	25	28	100	22	$5*10^{-3}$
20	90	?	53	30	46	$6*10^{-3}$
21	80	2	?	40	39	$3*10^{-3}$
22	60	4	68	?	61	$2*10^{-3}$
23	20	0,5	12	80	?	$4*10^{-3}$
24	120	10	39	59,25	32	?
25	?	18	21	50	17	$5*10^{-3}$
26	40	?	103	60	94	$2*10^{-3}$
27	120	10	?	70	112	$3*10^{-3}$
28	90	6	41	?	34	$5*10^{-3}$

Qaytarish uchun nazorat savollari

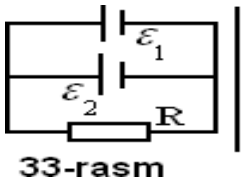
1. Kirxgof qonunlarini tushintirib bering.
2. Tarmoqlangan elektr zanjirlari uchun Kirxgof qonunlarini ta’riflab, tushuntiring.
3. Kirxgof qonunlari qanday fizik qonunlar asosida topilgan?

10-MUSTAQIL BAJARISH UCHUN TOPSHIRIQLAR

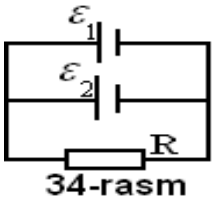
1.Elektr zanjiri ikkita galvanik elementdan, uchta qarshilikdan va galvanometrdan tuzilgan (32-rasm). Zanjirda r_1=100 Om, r_2=500 Om, r_3=20 Om. Birinchi elementni E.Yu.K. ε=2 V. Galvanometr I=50 mA tokni ko‘rsatadi, uning yo‘nalishi esa strelka bilan ko‘rsatilgan. Ikkinchi elementni E.Yu.K. $\varepsilon_2$ni toping. Galvanpmetrni qarshiligi va tok manbalarni ichki qarshiliklari etiborga olinmasin.



32-rasm



33-rasm



34-rasm

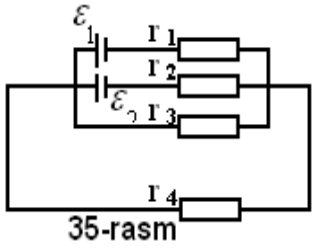
2. Ikki tok manbai: ε_1=14 V, ichki qarashiligi. r_1=2 Om va ε_2=6 V, ichki qarshiligi r_2=4 Om , hamda reostat R=10 Om 33-rasmda ko‘rsatilgandek ulangan. Reostatda va tok manbalarida tok kuchi aniqlansin.

3. Reostat uchlarida kuchlanish tushuvi va har bir elementdagi tok kuchi topilsin (34-rasm). Bunda ε_1=8 V, r_1=1 Om, ε_2=4 V. r_2=0.5 Om va R=50 Om.

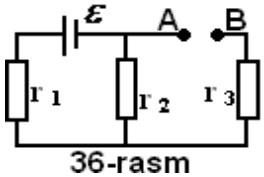
4. r_1=2 Om, r_2=r_3=4 Om va r_4=2 Om qarshiliklar va tok manbalari ε_1=10 V, ε_2=4 V 35-rasmdagidek ulangan bo‘lsa, shu qarshiliklardagi kuchlanishlar topilsin. Manbaning qarshiligi etiborga olinmasin .

5. Uchta qarshilik r_1=35 Om, r_2=1 Om, r_3=3 Om, hamda ε=1,4 V bo‘lgan element 36-rasmda ko‘rsatilgandek ulangan. r_3 qarshilikdan I=1 A tok strelka bilan ko‘rsatilgan yo‘nalishda o‘tishi uchun zanjirning A va B uchlariga qanday tok manbai ulashimiz kerak? Manbalarni ichki qarshiliklari etiborga olinmasin.

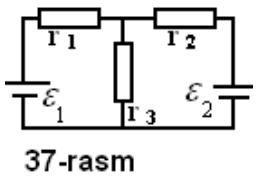
6. 37-rasmda ε_1=4 V, ε_2=3 V, r_1=2 Om, r_2=6 Om, r_3=1 Om bo‘lsa, r_3 qarshilikdan o‘tuvchi tok kuchi va shu qarshilikda kuchlanish tushuvi topilsin. Manbalarni ichki qarshiliklari etiborga olinmasin.



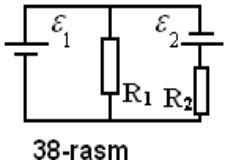
35-rasm



36-rasm



37-rasm

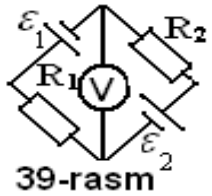


38-rasm

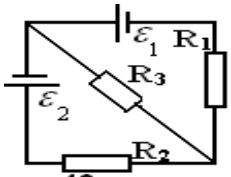
7. 38-rasmdagi zanjirda manbalarni E.Yu.K. ε_1=50. ε_2=10 V va ichki qarshiliklari r=1.5 Om, r_2=0.5 Om, R_0 qarshilikda tok kuchi nolga teng bo‘lganda, R_1 qarshilikni qiymati topilsin.

8. 39-rasmdagi sxemada ε=$\varepsilon_2$va R_1=R_2=100 Om. Voltmetrni qarshiligi R_v=100 Om, kuchlanishi esa U_v=200 V. Manbalarning ichki qarshillarini e’tiborga olmagan holda E.Yu.K. ε_1 va ε_2 larni toping.

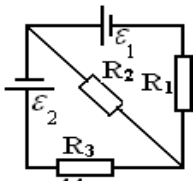
9. 39-rasmdagi sxemada $\varepsilon_1=\varepsilon_2$=400 V, $R_1=R_2$=400 Om. Voltmetrni qarshiligi R_v=200 Om. Voltmetrni ko‘rsatishi topilsin. Manbalarni qarshiliklari e’tiborga olinmasin.
10. 40-rasmdagi sxemada ε_1=10 V, ε_2=2 V, R_1=1 Om, R_2=4 Om , R_3=3 Om. Zanjirning hamma qismida tok kuchi topilsin. Manbalarni ichki qarshiliklari e’tiborga olinmasin.
11. 41-rasmdagi sxemada ε_1=1 V, ε_2=2 V, R_1=1 Om, R_2=4 Om, R_3=5 Om. Zanjirning hamma qismilaridagi tok kuchi topilsin Manbalarning ichki qarshiliklari e’tiborga olinmasin.
12. Uchta tok manbai ε_1=1 V, ε_2=3 V, ε_3=2 V 42-rasmda ko‘rsatilgadek ulangan. Manbalarning ichki qarshiliklari o‘zaro tengdir $r_1=r_2=r_3$=0.2 Om. Zanjirni bo‘laklaridagi tok kuchlari topilsin.



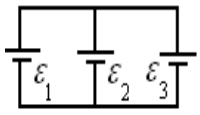
39-rasm



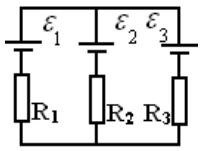
40-rasm



41-rasm

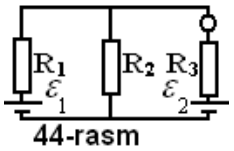


42-rasm

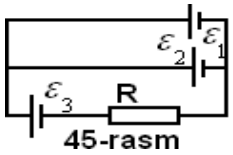


43-rasm

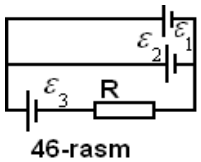
13.E.Yu.K. lari ε_1=10 V, ε_2=5 V, ε_3=1 V bo‘lgan manbalar R_1=1 Om, R_2=2 Om, R_3=3 Om qarshiliklar bilan 43-rasmda ko‘rsatilgandek ulangan. Qarshiliklardagi tok kuchi topilsin. Manbalarni ichki qarshiliklari etiborga olinmasin.
14. E.Yu.K.lari ε_1=2 V, ε_2=1.2 V bo‘lgan manbalar va R_1=900 Om, R_2=300 Om qarshiliklar 44-rasmdagidek ulangan bo‘lsa, galvanometr qanday tok kuchini ko‘rsatadi? R_1 qarshiliklarda kuchlanish tushuvi U_1=2 V. Manbalarni ichki qarshiliklari etiborga olinmasin.
15. Uchta tok manbai $\varepsilon_1=\varepsilon_2$=4 V, ε_3=6 V va reostat R=30 Om bo‘yicha ulangan. Agarda $r_1=r_3$=10 m va r_2=20 m bo‘lsa, reostatdagi tok topilsin.
16. Uchta galvanik element (ε_1= 1.3 V,ε_2=1.5 V,ε_3=2 V,$r_1=r_2=r_3$=0.2 m) 46-rasmda ko‘rsatilgandek ulangan. Qarshilik R=0.55 Om. elementlardagi tok topilsin.



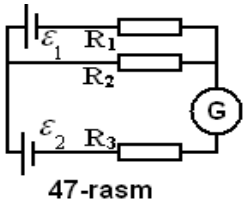
44-rasm



45-rasm

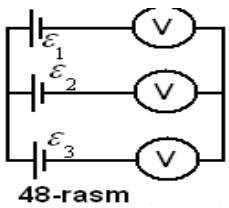


46-rasm

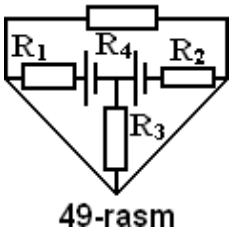


47-rasm

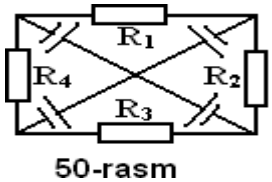
17.47-rasmdagi sxemada R_1=50 Om, R_2=200. Om, R_3=1000 Om, ε_1=1.8 V. Galvonometrdan o‘tuvchi I=0.5 mA tokni yo‘nalish strelka bilan ko‘rsatilgan. Galvanometrni qarshiligi va elementlari ichki qarshiliklarini etiborga olmasdan, ikkinchi galvanik elementni E.Yu.K. topilsin.



48-rasm



49-rasm



50-rasm

18. Uchta galvanik element va uchta voltmetr 48-rasmda ko‘rsatilgan sxema bo‘yicha ulangan. elementlarni E.Yu.K. lari ε_1=1 V, ε_2=2 B, ε_3=1.5. Voltmetrlarni qarshiliklari $R_1=2\cdot10^3$ Om, $R_2=3xI0^3$ Om, $R_3=4xI0^3$ Om. Agarda manbalarni qarshiliklarini juda kichik deb olsak, eletmetrlarni ko‘rsatishini toping.

19. 49-rasmda sxemada qarshiliklar $R_1=R_2=R_3=R_4=10$ Om, ε_1=1.5 V, ε_2=1.8, manbalarni ichki qarshiliklarini etiborga olmasdan qarshiliklardagi tok kuchlari nimaga tengligi topilsin.

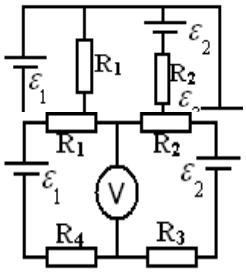
20. 50-rasmdagi sxemada har bir qarshilikdan o‘tuvchi tok I =0.1 A ga teng bo‘lishi uchun R_1, R_2, R_3, va R_4, qarshiliklarni qiymati qanday bo‘lishi kerak? Manbalarni ichki qarshiliklarini e’tiborga olmang, E.Yu.K. lari esa ε_1=1 V, ε_2=2 V, ε_3=3 V, ε_4=4 V ga teng.

21. E.Yu.K.lari ε_1=-2 V, ε_2=2,8 V, ε_3 =1.4 V va ichki qarshiliklari o‘zaro teng bo‘lib r =0.5 Om bo‘lsa , R_1=5 Om ga teng bo‘lgan 51-rasmdagi sxemada R_2=10 Om qarshilikdagi kuchlanish topilsin.

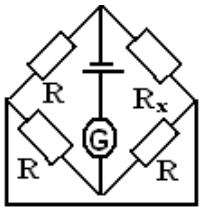
22. 52-rasmda ko‘rsatilgan sxema bo‘yicha ulangan voltmetrning ko‘rsatishini toping.Voltmetrning qarshiligi R_v=300 Om. Tok manbalarini E.Yu.K.lari $\varepsilon_1=\varepsilon_2$=2.2 V. Qarshiliklar R_1=100 Om, R_2=200 Om, R_3=400 Om, R_4=300 Om. Manbalarning ichki qarshiliklarini e’tiborga olmang.

23. 53-rasmda ko‘rsatilgan zanjirda galvanometrdan tok o‘tmagan paytda R_x qarshilikni qiymatini toping.Bunda R =9 Om, ε_1 =15 V, r_1=2.8 Om ε_2=2.7 V .

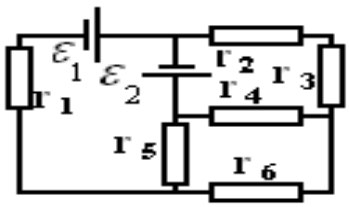
24. 54-rasmda ε_1=6.5 V, ε_2=3.9 V, $r_1= r_2= r_3= r_4= r_5= r_6$=10 Om bo‘lsa zanjirni har bir bo‘lagidan o‘tayotgan tok kuchi topilsin. Manbaning ichki qarshiligi e’tiborga olinmasin.



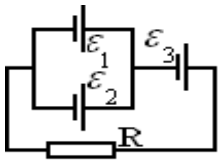
52-rasm



53-rasm



54-rasm



55-rasm

25. Uchta tok manbai ε_1=1.3V, ε_2=1.5 V vaε_3=2V va ichki qarshiliklari $R_1= R_2= R_3$=0.2 Om bo‘lgan zanjir 55-rasmdagidek ulangan. Qarshilik R=0.55 Om. Elementlardagi tok kuchlari I_1, I_2 va I_3 lar topilsin.

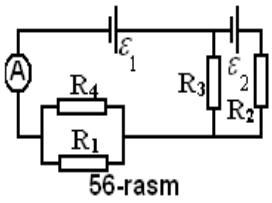
26. 56-rasmdagi sxemada $\varepsilon_1=2\varepsilon_2$, $R_1= R_3$=20 Om, R_2=15 Om, R_4=30 Om. Ampermetrni ko‘rsatishi I_1=1.5 A. R_2 va R_3 qarshiliklardan o‘tuvchi I_2 va I_3 tok kuchi va manbani E.Yu.K. lariε_1 va ε_2 lari topilsin.

27. 57-rasmdagi sxema bo‘yicha ulangan milliamperametrdan o‘tuvchi tok kuchi topilsin. $\varepsilon E_1= \varepsilon E_2$=1.5V, $R_1= R_2$=0.5 Om milliamperametrni qarshiligi R_A=3Om.

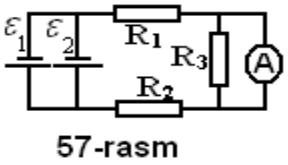
28. 58-rasmdagi zanjirda ε_1=2V, ε_2=5V, R_3=20 Om. Qarshiliklar shunday tanlanganki batareya E_1 dan tok o‘tmaydi. R_2 qarshilikni uchlaridagi kuchlanish U_2 nimaga teng? R_3 qarshilikdan o‘tuvchi tok kuchi I_3 ni qiymatini toping. Batareyalar qarshiligini e’tiborga olmang. R_1, R_2 va R_4 qarshiliklarni qiymatini toping.

29. 59-rasmda keltirilgan zanjirda hamma qarshiliklar va R_4 qarshilikdan o‘tuvchi tok I_4 ma’lumdir. Batareyani ichki qarshiliklari e’tiborga olinmasin. Manba E.Yu.K ε

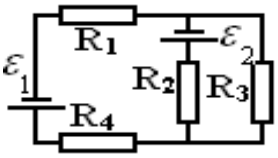
30. 60-rasmdagi zanjirda manbani E.Yu.K. ε=10V, R_1=5Om, R_2= R_3=1 Om, r=3 Om. Manbani ichki qarshiligini e’tiborga olmagan holda zanjirni har bir bo‘lagidan o‘tuvchi tok kuchi topilsin.



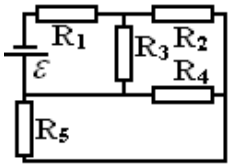
56-rasm



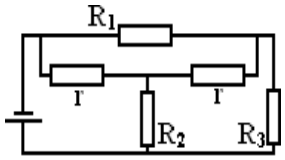
57-rasm



58-rasm



59-rasm



60-rasm