



TOSHKENT IRRIGATSIYA VA QISHLOQ
XO'JALIGINI MEXANIZATSIYALASH
MUHANDISLARI INSTITUTI



FAN: ELEKTR YURITMA VA ELEKTRONIKA

MAVZU

O'zgarmas tok zanjirlari va
ularni hisoblash usullari.



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Elektrotexnika va mexatronika kafedrası assistenti



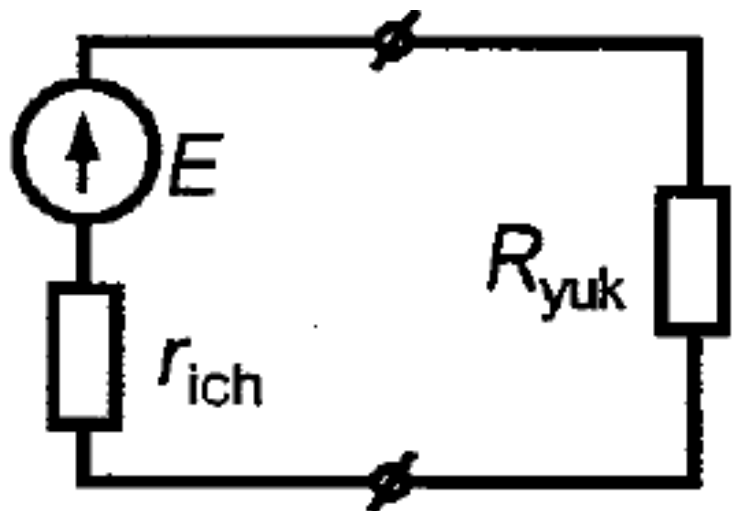
O'zgarmas tok zanjirlarini hisoblash.

O'zgarmas tok zanjirining bir qismidan o'tayotgan tok kuchlanishga to'g'ri, qarshilikka esa

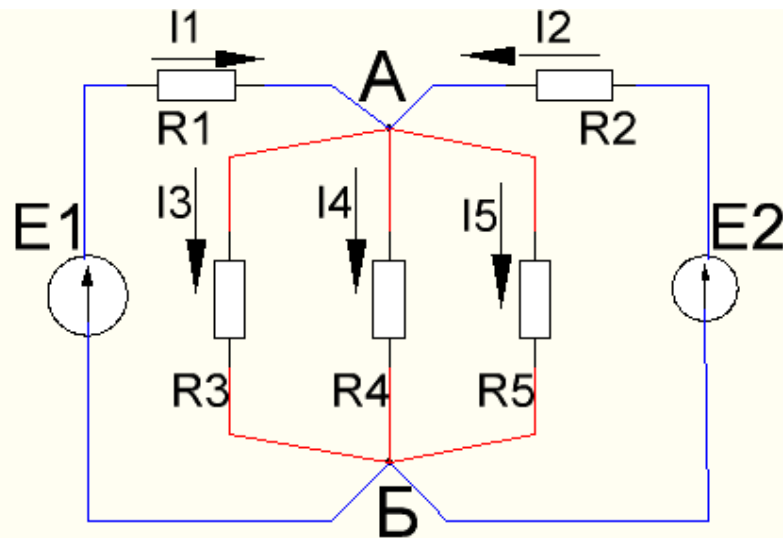
teskari proporsionaldir, ya'ni $I = \frac{U}{R}$

bunda U — o'tkazgich uchlaridagi kuchlanish, R — o'tkazgichning qarshiligi.

Berk zanjir uchun Om qornrni (rasm) quyidagicha ifodalanadi: $I = \frac{E}{r_{ich} + R_{yuk}}$



Bunda: E - manba EYuK, r_{ich} - manbaning ichki qarshiligi, R_{yuk} -yuklama qarshiligi



Kirxgof qonunlari murakkab (ikki va undan ortiq konturli) elektr zanjirlarni hisoblash va ularning elektr holatlarini to'la aniqlash uchun xizmat qiladi. Murakkab zanjirlar uchun **tarmoq**, **tugun** va **kontur** tushunchalar qo'llaniladi.

Tarmoq – elektr zanjirining ma'lum bir qismi bo'lib, ketma-ket birlashtirilgan qarshiliklar (rezistorlar), energiya manbalari va hokazolardan iborat.

Tugun - elektr zanjirining uchta va undan ortiq tarmoqlarining birlashgan joyi.

Kontur – zanjirning bir necha tarmoqlaridan iborat yopiq yo'l.

Masalan rasmdagi elektr zanjiri **beshta** tarmoq (bulardan ikkitasining energiya manbai bor), ikkita tugun va to'qqizta konturdan iborat.

Kirxgofning birinchi qonuni (*toklar qonuni*) elektr zanjirining tarmoqlanish tugunidagi toklarning qanday taqsimlanganligini ifodalaydi. Bu qonunga ko'ra, elektr zanjirining tarmoqlanish tuguniga kelayotgan va undan chiqib ketayotgan toklarning algebaik yig'indisi nolga teng.

Rasmdagi elektr zanjirining **A** tuguni uchun

$$I_1 + I_2 - I_3 - I_4 - I_5 = 0$$

deb yozish mumkin. Bunda tarmoqlanish tuguni kelayotgan toklarni (+) ishora va undan chiqib ketayotgan toklarni (-) ishora bilan olgan bo'lamiz. Umumiy holda

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

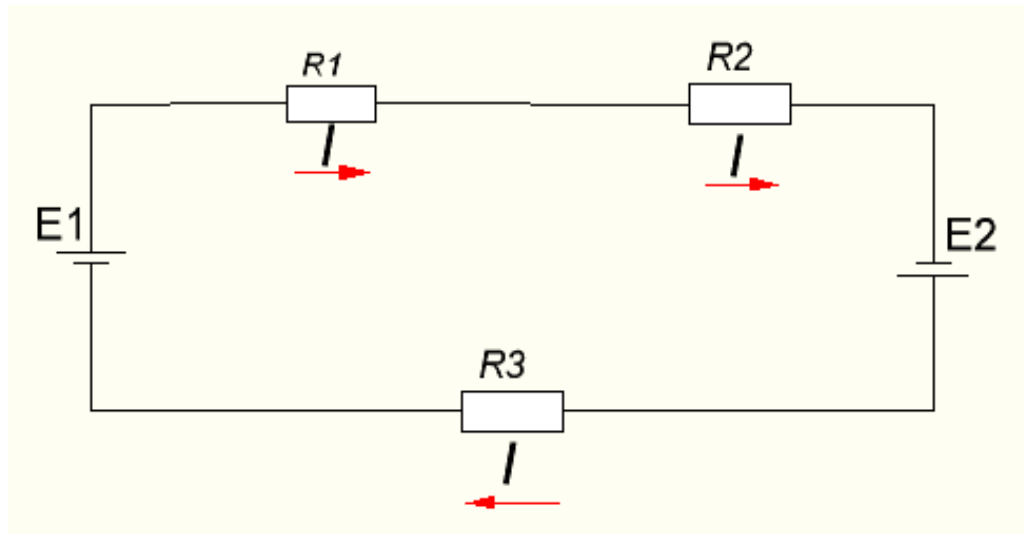
Kirxgofning ikkinchi qonuni (*kuchlanishlar qonuni*) berk elektr zanjirining qismlarida EYuK va kuchlanishlarning qanday taqsimlanganligini aniqlashga yordam beradi.

Binobarin, berk konturdagi barcha EYuK larning algebaik yig'indisi shu konturning barcha qismlaridagi kuchlanishlar pasayishining algebaik yig'indisiga teng.

$$\sum_{k=1}^n E_k = \sum_{k=1}^n I_k$$

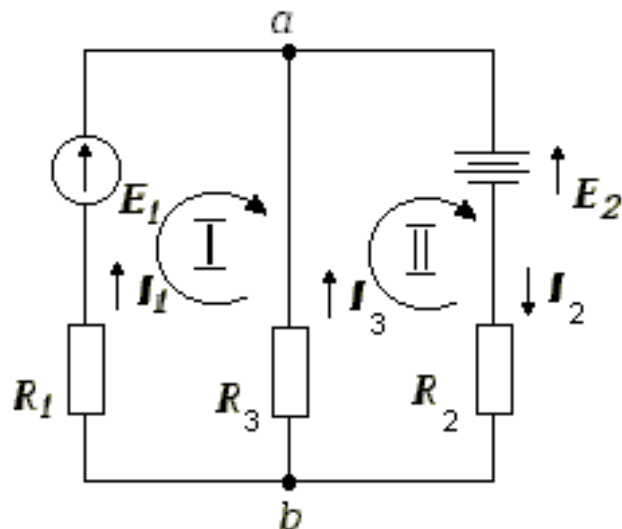
Kirxgofning ikkinchi qonuniga binoan rasmda ko'rsatilgan elektr zanjirida EYuK ning shartli musbat yo'nalishi bo'yicha, (ya'ni, soat milining harakat yo'nalishi bo'yicha) zanjirning elektr muvozanat tenglamasi quydagicha yoziladi.

$$E_1 + E_2 = IR_1 + IR_2 + IR_3.$$



Zanjirdagi har qanday nuqtaning potentsiali mazkur nuqtaning zanjirdagi holati bilan aniqlanadi. Umumiy holda $\sum E - \sum IR = 0$ deb yozish mumkin.

O'zgarmas tok zanjirlariga oid masalalar.



masalaga tegishli sxema

Masalaning yechilishi:

1. Kirxgof tenglamalarini tuzish usuli.

a) zanjir tarmoqlaridagi toklarga ixtiyoriy yo'nalish beriladi rasm ko'rsatilgan.

b) berk konturlarda konturni aylanib chiqish yoʻnalishini ixtiyoriy tanlaymiz rasmda soat mili harakati yoʻnalishida;

v) zanjirdagi tarmoqlar soni $m=3$, tugunlar soni $n=2$;

g) zanjirning ixtiyoriy tuguni, masalan a tuguni uchun, Kirxgofning **1-qonuni** asosida $n-1=2-1=1$ ta tenglama tuzamiz:

$$I_1 + I_3 - I_2 = 0$$

d) zanjirning berk konturlari uchun Kirxgofning **2-qonuni** asosida $m-(n-1)=3-(2-1)=2$ ta tenglama tuzamiz:

$$R_1 * I_1 - R_3 * I_3 = E_1$$

$$R_3 * I_3 + R_2 * I_2 = E_2$$

Tuzilgan $m=3$ ta tenglamalarni nomaʼlum toklarga nisbatan yechamiz. Bunda Kramer usulidan foydalanish mumkin.

$$\begin{cases} I_1 - I_2 + I_3 = 0 \\ R_1 I_1 + 0 \cdot I_2 - R_3 \cdot I_3 = E_1 \\ 0 \cdot I_1 + R_2 \cdot I_2 + R_3 \cdot I_3 = -E_2 \end{cases}$$

$$\Delta = \begin{vmatrix} 1 & -1 & 1 \\ 0,2 & 0 & -20 \\ 0 & 0,2 & 20 \end{vmatrix} = 4 + 4 + 0,04 = 8,04$$

$$\Delta_1 = \begin{vmatrix} 0 & -1 & 1 \\ 12 & 0 & -20 \\ -24 & 0,2 & 20 \end{vmatrix} = 240 - 480 + 2,4 = -237,6$$

$$\Delta_2 = \begin{vmatrix} 1 & 0 & 1 \\ 0,2 & 12 & -20 \\ 0 & -24 & 20 \end{vmatrix} = 240 - 4,8 - 480 = -244,8$$

$$\Delta_3 = \begin{vmatrix} 1 & -1 & 0 \\ 0,2 & 0 & 12 \\ 0 & 0,2 & -24 \end{vmatrix} = -2,4 - 4,8 = -7,2$$

Tarmoqlardagi toklar quyidagicha aniqlanadi:

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{-237,6}{8,04} = -29,55 \text{ A}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-244,8}{8,04} = -30,45 \text{ A}$$

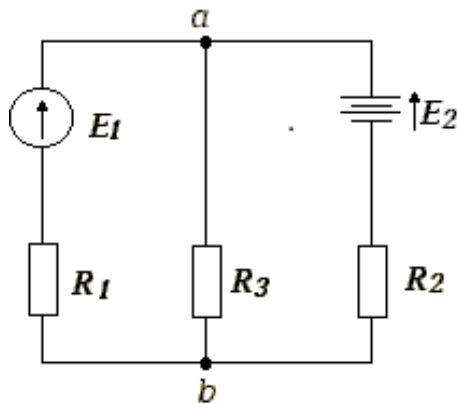
$$I_3 = \frac{\Delta_3}{\Delta} = \frac{-7,2}{8,04} = -0,895 \text{ A}$$

Toklarning aniqlangan qiymatlarini to'g'riligini tekshirishda *a* tugun uchun tuzilgan **Kirxgofning 1- qonunidan** foydalanish mumkin, ya'ni

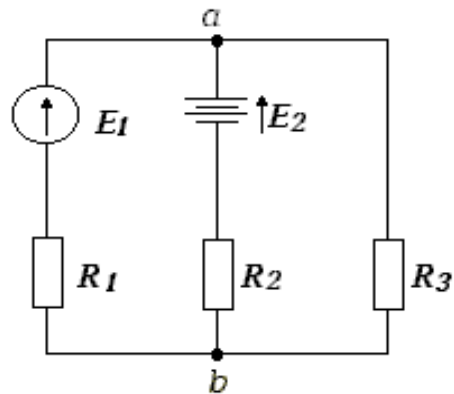
$$I_1 - I_2 + I_3 = 0, \quad -29,55 + 30,45 - 0,895 = 0.$$

Uy topshirig'i va variantlar:

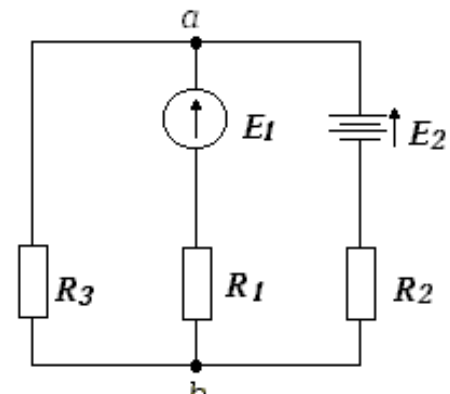
1.1 – 1.12-rasmgach bo'lgan sxemalardan foydalanib. 1-jadvaldan berilgan qiymatlarni olib talabalar o'z variantlari bo'yicha tarmoqlardagi toklarini **Kirxgofning birinchi va ikkinchi qonunlari** bo'yicha tenglamalarini tuzish va ustma-ustlash usullari yordamida aniqlansin hamda quvvatlar balansi tenglamasi tuzilsin.



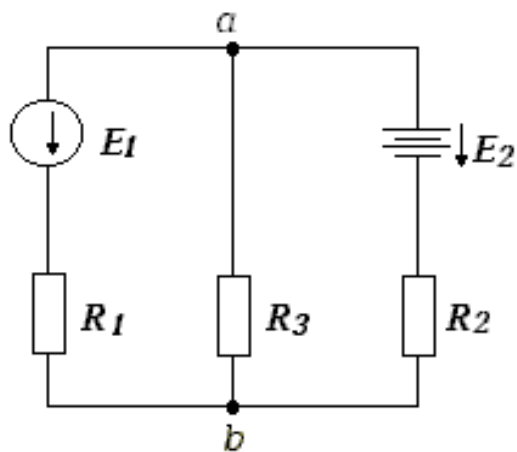
1.1-rasm .



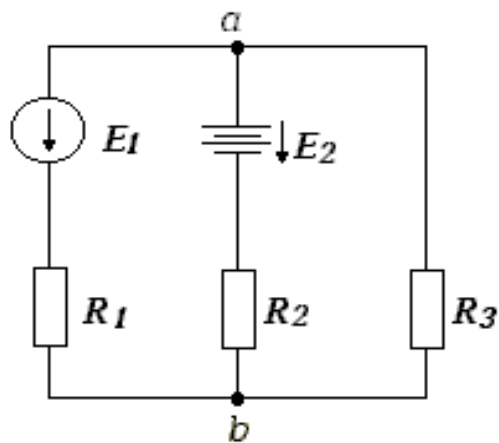
1.2-rasm.



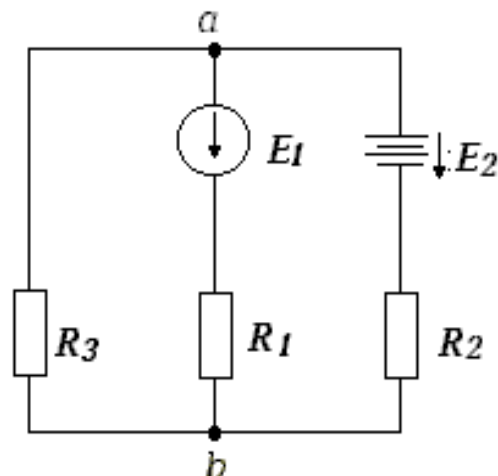
1.3-rasm.



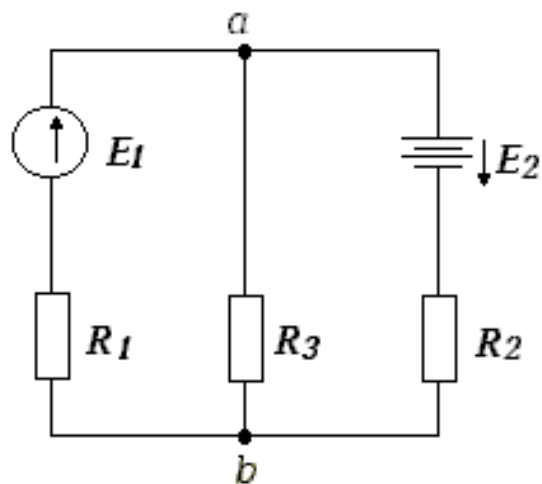
1.4-rasm.



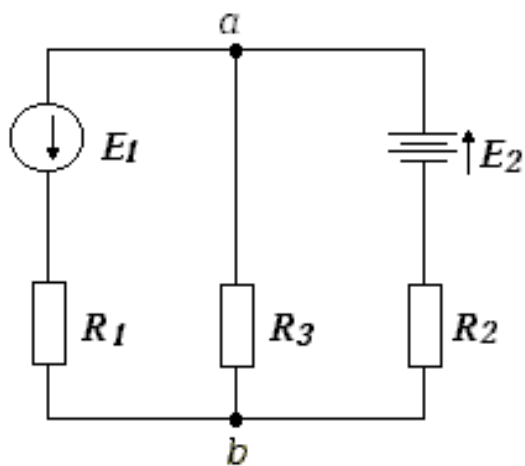
1.5-rasm.



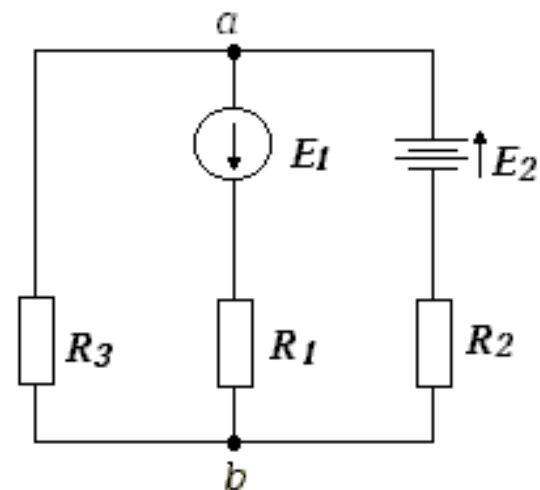
1.6-rasm.



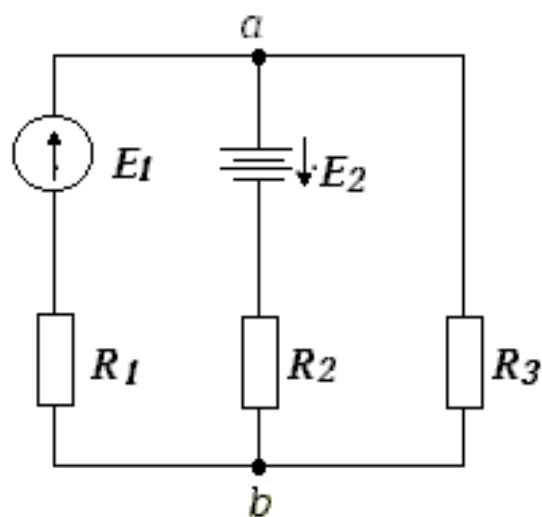
1.7-rasm.



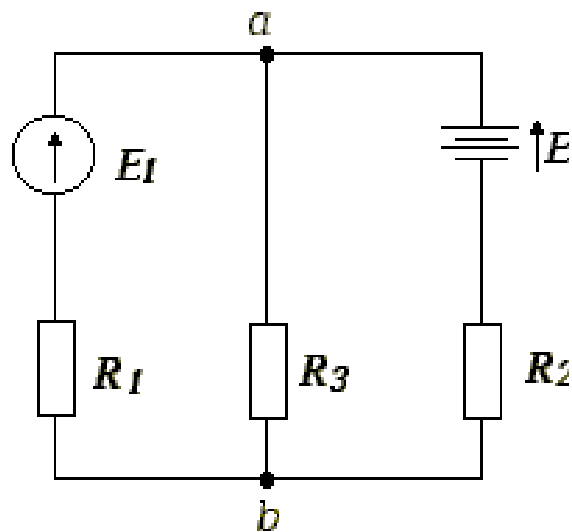
1.8-rasm.



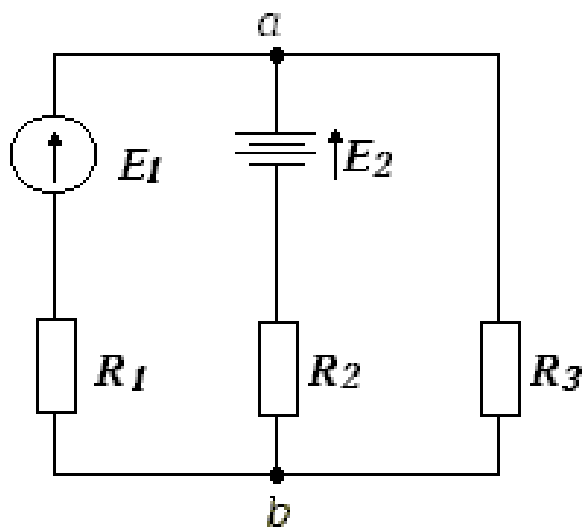
1.9-rasm.



1.10-rasm.



1.11-rasm.



1.12-rasm.

Variant	Rasm	R ₁	R ₂	R ₃	E ₁	E ₂
		Om			V	
1	2	3	4	5	6	7
1	1.1	7	10	4	21	10
2	1.2	5	13	2	10	21
3	1.3	13	10	10	30	12
4	1.4	80	100	35	150	100
5	1.5	18	5	10	20	80
6	1.6	9	10	5	16	8,2
7	1.7	40	60	80	13	12
8	1.8	3	5	8	20	14
9	1.9	80	100	40	25	10
10	1.1	45	150	80	25	8
11	1.1	7	4	9	20	10

Variant	Rasm	R ₁	R ₂	R ₃	E ₁	E ₂
		Om			V	
1	2	3	4	5	6	7
12	1.12	22	10	14	23	9,5
13	1.11	12	10	9	13	14
14	1.10	6	10	15	20	7,6
15	1.9	7	10	12	10	20
16	1.8	4	11	7	20	4,5
17	1.7	16	40	30	30	10
18	1.6	5	10	7	15	13
19	1.5	7	10	15	15	20
20	1.4	6	15	21	14	25
21	1.3	19,5	13,5	17	9	45
22	1.2	3	12	16,5	30	12

Va-ri-ant	Rasm	R ₁	R ₂	R ₃	E ₁	E ₂
		Om			V	
1	2	3	4	5	6	7
23	1.1	6	9	15	21	23,5
24	1.2	30	120	225	90	37,5
25	1.3	15	27	15	16,5	52,5
26	1.4	19,5	13,5	15	16,2	15
27	1.5	195	80	90	18	32
28	1.6	12	10	21	15	33
29	1.7	150	105	60	25,5	22,5
30	1.12	10	165	90	15	12
31	1.11	13,5	6	10,5	21	14
32	1.10	60	33	75	16,5	25,5
33	1.9	18	15	10,5	30	15
34	1.8	18	33	9	9	18
35	1.7	10,5	15	30	9	30
36	1.6	16,5	7,5	18	25	15,5
37	1.5	30	24	60	16	27
38	1.4	7,5	15	8	37,5	15
39	1.3	10,5	7,5	15	45	55
40	1.2	12	15	9	25,5	30
41	1.1	6,5	2,5	4,5	4	15
42	1.2	1	4	7,5	5	10
43	1.3	2	3	5	11	7,5
44	1.4	10	40	50	34	125

Va-ri-ant	Rasm	R ₁	R ₂	R ₃	E ₁	E ₂
		Om			V	
1	2	3	4	5	6	7
45	1.5	5	9	4	8,2	17
46	1.7	2	6,5	4,5	6,7	5
47	1.1	65	20	40	4,7	12,5
48	1.11	3	25	7	7,5	11
49	1.12	40	50	60	6,5	7,5
50	1.1	55	30	22,5	8,1	7
51	1.3	6	2	4	7	5
52	1.2	20	11	25	7,5	80
53	1.5	7,5	6	5	3,5	10
54	1.7	6	17,5	5	6,5	6
55	1.12	2	6	10	30	25
56	1.1	5,5	2,5	7	10,5	5
57	1.7	10	8	20	10	9
58	1.8	5	6	4	6	12,5
59	1.8	5	2	10	10,5	20
60	1.7	5	7,5	10,5	7	10
61	1.2	26	10	14	34	20
62	1.3	10	22	1	32	25
63	1.5	20	26	18	60	24
64	1.12	160	200	300	200	100
65	1.6	36	10	16	40	50
66	1.1	16	8	20	11	32
67	1.2	260	120	160	24	38

Va-ri-ant	Rasm	R ₁	R ₂	R ₃	E ₁	E ₂
		Om			V	
1	2	3	4	5	6	7
68	1.3	28	14	16	45	18
69	1.4	160	110	80	50	22
70	1.5	120	220	90	50	32
71	1.6	14	24	30	45	22
72	1.12	80	60	28	110	44
73	1.11	30	24	20	26	38
74	1.10	70	44	14	40	21,5
75	1.9	8	24	40	40	20
76	1.7	23	23	85	50	16,5
77	1.8	18	42	30	60	28
78	1.4	24	10	20	30	36
79	1.5	10	24	35	35	15
80	1.2	42	30	52	55	38
81	1.6	32	18	25	20	70
82	1.9	5	20	30,5	35	60
83	1.2	15	20	35	45	30,5
84	1.1	200	50	375	150	320
85	1.3	45	25	15	34	77,5
86	1.7	32,5	25,5	17	29	19
87	1.8	320	175	255	14	64,5

Va-ri-ant	Rasm	R ₁	R ₂	R ₃	E ₁	E ₂
		Om			V	
1	2	3	4	5	6	7
88	1.12	18	33	44	25	55
89	1.3	200	137	145	31,7	32,8
90	1.6	150	115	275	35	28
91	1.1	30	10	20	26	12
92	1.12	75	100	35	32,5	37,5
93	1.10	30	22,5	25	50	35
94	1.4	55	36,5	13,5	15	34
95	1.8	17,5	11,5	9,5	45	18
96	1.11	21,5	18,5	35	44	17
97	1.2	50	100	55	35	25
98	1.5	25	30	20	30	55
99	1.3	13,5	19,5	50	70	10
100	1.10	44	49	68	100	75



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