O’ZBEKISTON ALOQA VA AXBOROTLANISH AGENTLIGI
TOSHKENT AXBOROT TEXNOLOGIYALARI UNIVERSITETI

Elektr zanjirlar
nazariyasi kafedrasi

ELEKTR ZANJIRLARI NAZARIYASI

fanidan kurs ishini
bajarish uchun

Referat

Toshkent 2013

I – tartibli elektr zanjirlarda o`tish jarayonlarini klassik va operator usullari bilan hisoblash.

I.1. N – variant raqami bo'yicha (N – talabalarning gurush jurnalidagi tartibi) sxema tanlang va uning elementlari qiymatlarini hisoblang.
(Sxema I. I-rasmda keltirilgan)

$$E = (M + K),\ [B];$$

$$I = (10 + M - K),\ [мА];$$

$$R_1 = \frac{M + K}{2},\ [кОм];$$

$$R_2 = \frac{M + K}{4},\ [кОм];$$

$$R_3 = (M + K - 1),\ [кОм];$$

$$L = \left(\frac{M + K}{2} + 2\right),\ [мГн];$$

$$C = \frac{M + K}{2},\ [мкФ];$$

bu yerda M – guruh nomerining oxirgi raqami;
K = 2- TT va KT fakulteti uchun;
K = 4 TUT fakulteti uchun;
K = 6 RRT fakulteti uchun;
K = 8 maxsus fakultet uchun.

I.2.Reaktiv elimentlardagi o'tish toki va kuchlanishini klassik usulda hisoblang.

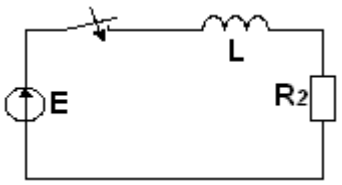
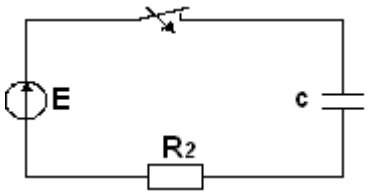
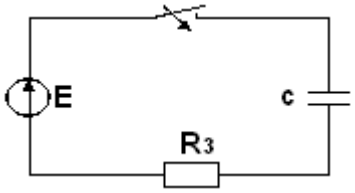
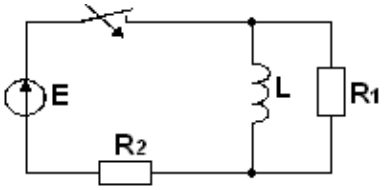
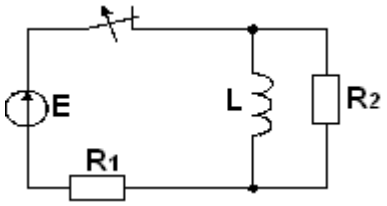
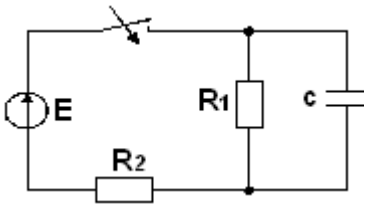
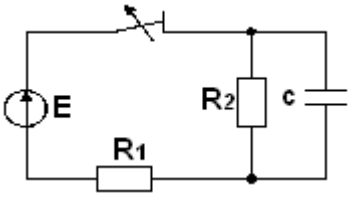
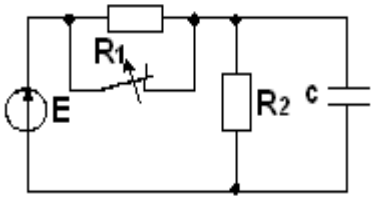
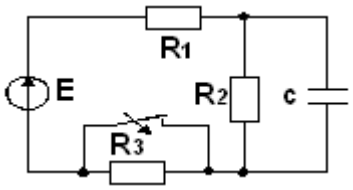
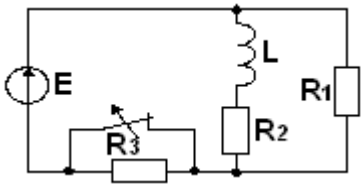
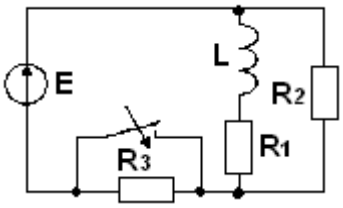
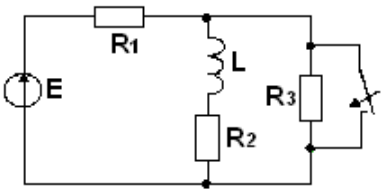
I.3. Zanjirning vaqt doimiysini hisoblang.

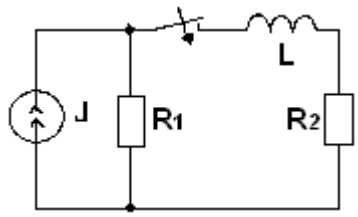
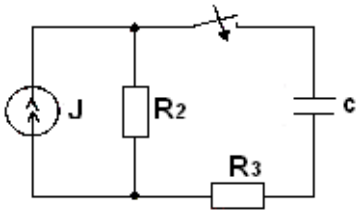
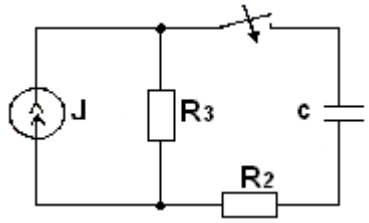
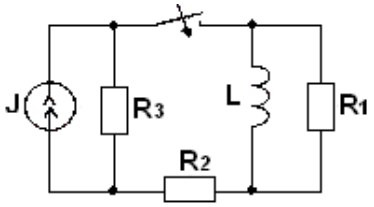
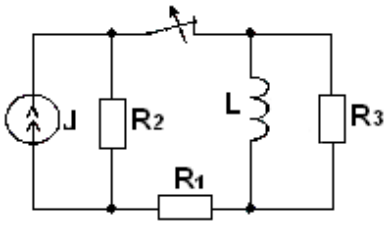
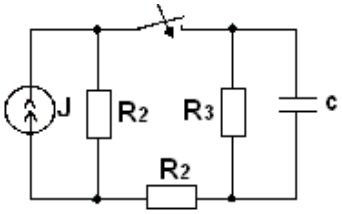
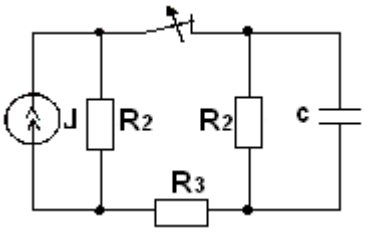
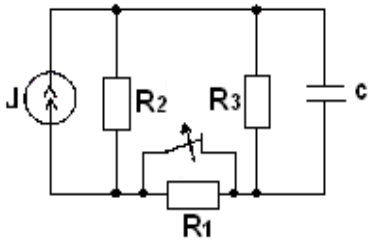
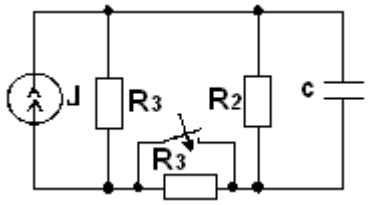
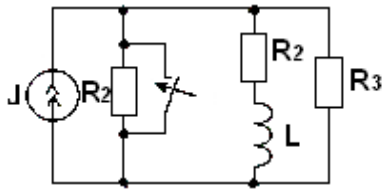
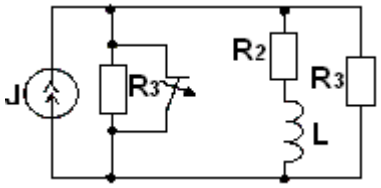
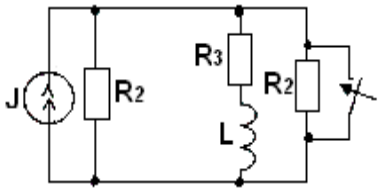
I.4. Vaqtning quyidagi qiymatlarida:

1) $t = 0$ 2) $t = \frac{\tau}{2}$ 3) $t = \tau$

4) $t = 2\tau$ 5) $t = 3\tau$ 6) $t = 4\tau$

I.5. O’tish toki va kuchlanishi grafiklarini chizing.

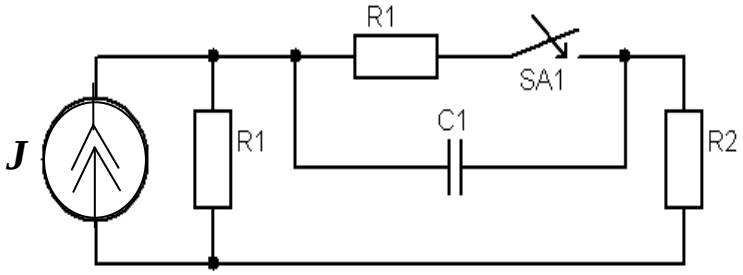
1 	2 
3 	4 
5 	6 
7 	8 
9 	10 
11 	12 

13 	14 
15 	16 
17 	18 
19 	20 
21 	22 
23 	24 

Hisoblash uchun namuna.

1)boshlang'ich ma'lumotlar: N =24 va guruh A-200 bo'lganda:

I = 10 Ma, R1=2 kOm, R2=1kOm, R3=4kOm, S=4mkF.



1.2– rasm. Tekshiralayotgan sxema

2)reaktiv elementlardagi o'tish toki va kuchlanishini hisoblaymiz.

DIQQAT! R L zanjir uchun hisob induktivligidagi tokni aniqlashdan RC zanjir uchun sig'imdagi kuchlanishni aniqlashdan boshlanadi.

Ko'rilayotgan zanjir RC zanjir bo'lgani sababli, hisobni sig'imdagi kuchlanishni anilashdan boshlaymiz. Buning uchun hisobni qo'yidagi tartibda olib boramiz:

a) reaktiv eliment va real manbaga ega bo'lgan ekvivalent sxema (kommutatsiyadan keyingi) ning parametrlarini hisoblash;

b) sxemening differintsial tenglamasini tuzish;

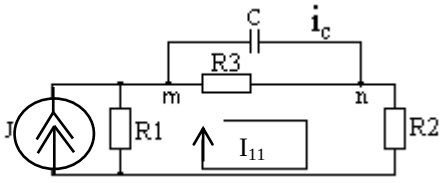
v) differentsial tenglamani yechish;

g) kommutatsiyagacha bo'lgan sxema uchun sirimdagi boshlangich kuchlanishni aniqlash maqsadida zanjirni hisoblash;

d) integrallash doimiysini aniqlashyu. So'nggi to'rt bosqich klassik usulga xos dir.

2.I Kommutatsiyadan keyin hosil bo'lgan sxemani (I.3a-rasm), ekvivalent manba usuliga asosan, real manba va reaktiv elementdan iborat bilgan (I.3b-rasm) ekvivalent sxema bilan almashtiramiz.

а)



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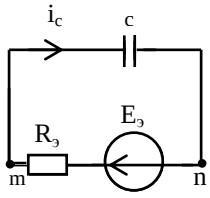


A sxema qismi

I.3-rasm. Kommutatsiyadan keyingi tekshirilayotgan zanjir.

$R_э$ va $E_э$ parametrlarni reaktiv elementga ulangan A sxema qismidan topish mumkin. Bu 1.4-rasmda ko'rsatilgan.

$E_э$ E.YU.K. ni va *m n* uchlar orasidagi υ si kichlanishidek aniqlaymiz.

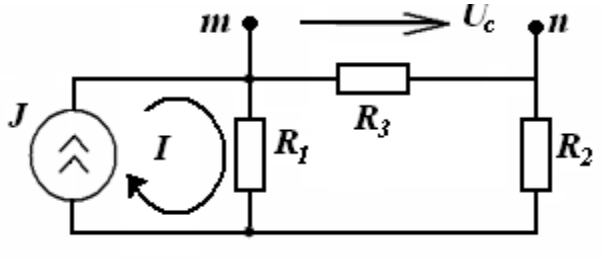
Kontur toklar usulida foydalanamiz.

1.4.-rasmga asosan quyidagini yozamiz:

$$I_{11}(R_1 + R_2 + R_3) - J \cdot R = 0;$$

$$I_{11} = I\frac{R_1}{R_1 + R_2 + R_3} = 10\ \frac{2}{2+1+4} = 2{,}857 \quad \text{мА};$$

$$E э = U_{XX} = I_{11} \cdot R_3 = 2{,}857 \cdot 4 = 11{,}4\ 3 \quad \text{В}.$$



1.4-rasm. Ekvivalent generator parametrini aniqlash uchun sxema.

$R_э$ qarshilikni passiv N sxema qismining *m* va *n* uchlari orasidagi qarshilik ko'rinishida olamiz (bu qism A sxema qismidagi tok manbalarini qisqa tutashtirish orqali hosil qilinadi). Bu holda zanjirning ekvivalent qarshiligi quyudagiga teng.

$$R э = \frac{R_3(R_1 + R_2)}{R_1 + R_2 + R_3} = \frac{4 \cdot (2+1)}{4+3+2} = 1{,}71 \quad \text{Ом}.$$

2.2 Ekvivalent sxemani (I.3b-rasm) tasvirlovchi diferentsial tenglama tuzamiz. $U_R+U_C=E_Э$,bu yerda

$$u_R = R_э \cdot i_c = R_э C\frac{du_C}{dt} \qquad \text{yoki} \qquad R_э C\frac{du_C}{dt} + u_C = E_э$$

2.3 Yechimini quyudagi ko'rinishda qidiramiz.

$$U_c=U_{см}+U_{cэ}$$

Majburiy tashkil etuvchi bir jinsli bo’lmagan diferentsial tenglamani xususiy yechimi ko'rinishida qidiriladi:

$$R_э C\frac{du_{спр}}{dt} + u_{спр} = E_э$$

Bu tashkil etuvchi birinchi qism ko'rinishi kabi, ya'ni $U_{см}$=const bilishi kerak. Oxirgi tenglamadan quyidagi kelib chiqadi:

$$U_{см}=E_э=11{,}43\ V,\quad \left[\frac{du_{см}}{dt}=0\right]$$

Erkin tashkil etuvchi bir jinsli diferentsial tenglamaning umumiy yechimini ko'rinishda qidiriladi:

$$R_э C\frac{du_{сэ}}{dt}+u_{сэ}=0$$

Unga mos keladigan xarakteristik tenglama quyudagi kirinishda bo'ladi:

$$R_э\cdot S\cdot R+I=0$$

bundan

$$P=-\frac{I}{R_э\cdot C}=-\frac{I}{1{,}71\cdot 10^{3}\cdot 4\cdot 10^{-6}}=-146{,}2\quad c^{-1}.$$

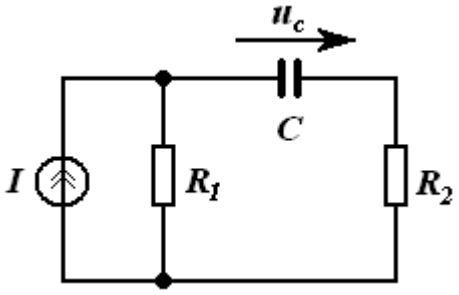
Erkin tashkil etuvchini quyidagi kirinishda yozish mumkin:

$$u_{сэ}=A\cdot e^{pt}=A\cdot e^{-146{,}2t}$$

bu yerda A-no'ma'lum integrallash doimiysi.

Umumiy yechim quyidagi kirinishda yoziladi: $u_c(t) = 11{,}43+Ae^{-146,2t}$

2.4 Kommutatsiyagacha sxema I.5-rasmda ko'rsatilgan kirinishda edi.



I.5-rasm. Kommutatsiyagacha bo'lgan zanjirning ekvivalent sxemasi.

O'zgarmas tok sigimi orqali oqmaydi, shu sababli R_2 dagi kuchlanish pasayishi 0 ga teng. Bundan kelib chiqib S dagi kuchlanishni R_1 dagi kuchlanishga teng deb hisoblaymiz:

$$U_c(0)=I\ R_1=10.2=20\ V$$

2.5 Boshlangich shartlardan foydalanib,integrallash doimiysi A ni topamiz:

$$U_c(0)=11{,}43+A=20\ V$$

$$A=8{,}57\ V$$

Yechimni aniqlaymiz:

$$U_c=11{,}43+8{,}57e^{-146,2t}\ V.$$

Sirimdagi tokni aniqlaymiz:

$$I_C=c\frac{du_c}{dt}=-410^{-6}\ 8{,}57146{,}2\ e^{-146,2t}=-5{,}01e^{-146,2t}\ mA$$

3)vaqt doimiysini hisoblaymiz:

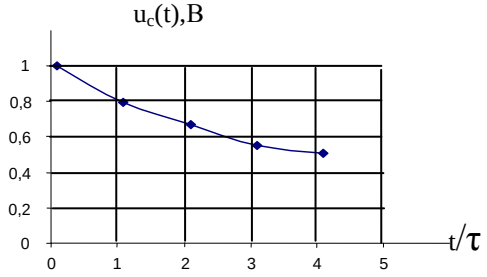
$$\tau = R_э \cdot C = \frac{1}{146,2} = 6,84 \cdot 10^{-3} \quad c.$$

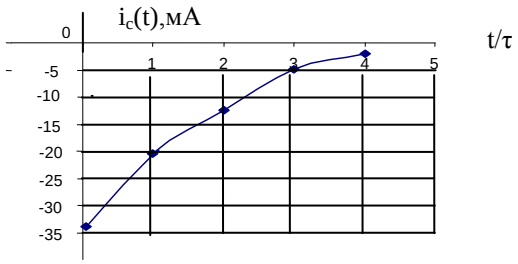
4)reaktiv elementdagi o'tish toki va kuchdanish uchun son qiymatlar jadvalini tuzamiz (1.2- jadv.)

1.2- jadval

t/τ	0	0,5	1	2	3	4
t, мс	0	3,42·10	6,84·10	13,68·10	20,52·10	27,36·10
$e^{p_1 t} = e^{-t/\tau}$	1	0,606	0,368	0,0135	0,050	0,018
$i_c = -5,01 \cdot e^{-\frac{t}{\tau}}$, мА	-5,01	-3,03	-1,84	-0,68	-0,25	-0,09
$u_c = 11,43 + 8,57$, В	20,0	16,62	14,58	12,58	11,85	11,58

5) ытиш токи ва кучланиш графикларини чизамиз.





1.5-расм. Си\имдаги ытиш кучланиши. 1.6-расм. Си\им ор=али ытиш токи.

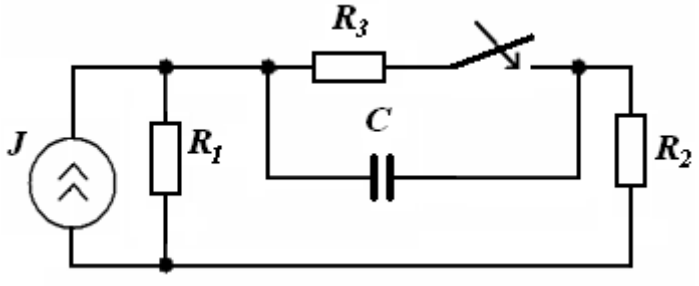
2.1 Sxema va uning parametrlari qiymatlarini usuldan oling.

2.2 Reaktiv elementdagi io'tish toki va kuchlanishini operator usulda shisoblang.

2.3 O'tish toki va kuchlanishining hisoblab topilgan ifodasini 1-topshiriqdagi klassik usulda topilgan ifodalar bilan taqqoslang.

Hisoblash uchun namuna.

1)1- topshirikqdan sxema va uning parametrlari qiymatlarini olamiz.



2.1-rasm. Tekshirilayotgan zanjir.

2)reaktiv elementdagi o'tish toki va kuchlanishni operator usulda hisoblaymiz. Hisobni quyidagi tartibda olib boramiz:

2.1) ta'sir funktsiyasining tasvirini aniqlash;

2.2) tok va kuchlanish shaqiqiy qiymat (original) laridan ularning Laplas bo'yicha tasvirlariga o'tish va ekvivalent operator sxema tuzish;

2.3) tok va kuchlanishlarning tasvirlarini hisoblash;

2.4) aniklangan tasvirlardan haqiqiy qiymat (original) larga qayta o'tish;

3.1) ta'sirning (berilgan tokning) tasvirini aniqlaymiz.

$$J(p) = \frac{J}{p} = \frac{10 \cdot 10^{-3}}{p}$$

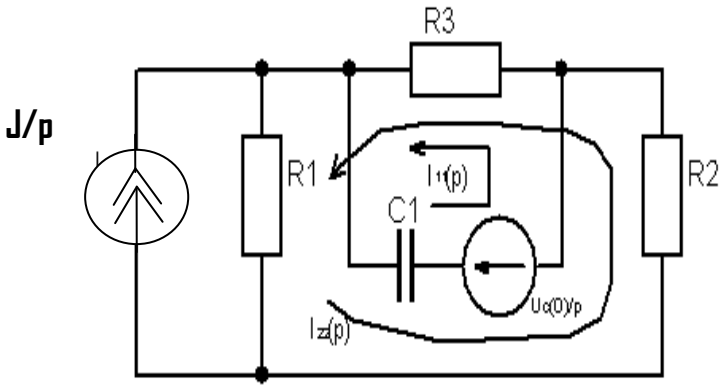
3.2) Ekvivalent operator sxemani tuzamiz (2.2-rasmga qarang)

1-topshiriqqa asosan (kommutatsiyagacha bo'lgan rejimni hisoblash)

Uc(0)= 20 V

3.3) Kondansatorli tarmoqdagi tok va undagi kuchlanishning tasvirlarini hisoblaymiz.

Hisob uchun kontur toklar usulini tanlaymiz.



2.2- rasm. Tekshirilayotgan zanjirning ekvivalent operator sxemasi.

$$\begin{cases} I_{11}(p)\cdot(R_3+\dfrac{1}{pC})+I_{22}(p)\cdot R_3=-\dfrac{U_c(0_-)}{p}, \\ I_{11}(p)\cdot R_3+I_{22}(p)\cdot(R_1+R_2+R_3)+\dfrac{J}{p}\cdot R_1=0; \end{cases}$$

$$\begin{cases} I_{11}(p)\cdot(R_3+\dfrac{1}{pC})+I_{22}(p)\cdot R_3=-\dfrac{U_c(0_-)}{p}, \\ I_{11}(p)\cdot R_3+I_{22}(p)\cdot(R_1+R_2+R_3)=-\dfrac{J}{p}\cdot R_1; \end{cases}$$

$$\Delta(p)=\begin{vmatrix} R_3+\dfrac{1}{pC} & R_3 \\ R_3 & R_1+R_2+R_3 \end{vmatrix}=\left(R_3+\frac{1}{pC}\right)\cdot(R_1+R_2+R_3)-R_3^2=R_1\cdot R_3+R_2\cdot R_3+R_3^2+$$

$$+\frac{R_1+R_2+R_3}{pC}-R_3^2=12\cdot10^6+\frac{7\cdot10^3}{4p\cdot10^{-6}}=\frac{12\cdot10^6p+1{,}75\cdot10^9}{p};$$

$$\Delta_{11}(p)=\begin{vmatrix} -\dfrac{u_c(0)}{P} & R_3 \\ -\dfrac{I}{P}\cdot R_1 & R_1+R_2+R_3 \end{vmatrix}=-\frac{u_c(0)}{P}(R_1+R_2+R_3)+\frac{I}{P}\cdot R_1\cdot R_3=$$

$$-\frac{20}{P}(2\cdot10^3+1\cdot10^3+4\cdot10^3)+\frac{10\cdot10^{-3}}{P}\cdot2\cdot10^3\cdot4\cdot10^3=$$

$$\frac{-140\cdot10^3+80\cdot10^3}{P}=-\frac{60\cdot10^3}{P};$$

$$I_{11}(P)=\frac{\Delta_{11}(P)}{\Delta(P)}=\frac{-\dfrac{60\cdot10^3}{P}}{\dfrac{12\cdot10^6P+1{,}75\cdot10^9}{P}}=\frac{-60\cdot10^3}{12\cdot10^6P+1{,}75\cdot10^9}=\frac{F_1}{F_2};\quad I_c(P)=I_k(P);$$

$$I_c(P)=-\frac{-60\cdot10^3}{12\cdot10^6P+1{,}75\cdot10^9}=\frac{F_1}{F_2};$$

Sigimdagi kuchlanishning tasviri:

$$U_c(p)=I_c(p)\frac{1}{pC}+\frac{u_c(0)}{p}=-\frac{-60\cdot10^3}{12\cdot10^6p+1{,}75\cdot10^3}\cdot\frac{1}{p\cdot4\cdot10^{-6}}+\frac{20}{P}=\frac{-60\cdot10^3}{(12\cdot10^6p+1{,}75\cdot10^3)4\cdot p}+\frac{20}{P}=$$

$$\frac{-15\cdot10^9+240\cdot10^6+35\cdot10^9}{p\cdot(12\cdot10^6p+1{,}75\cdot10^3)}=\frac{240\cdot10^6p+20\cdot10^9}{p\cdot(12\cdot10^6p+1{,}75\cdot10^3)}=\frac{F_3(P)}{P\cdot F_2(P)};$$

3.4) Yoyish teoremasidan foydalanib tok va kuchlanishlarning haqiqiy qiymatlarini hisoblaymiz:

$$I_c(P) = i_c(t) = \sum_{k=1}^{n} A_k \cdot e^{P_k t}, \qquad \text{bu yerda} \quad A_k = \frac{F_1(P_k)}{F_2^1(P_k)};$$

$$\text{yoki} \quad A_k = \lim_{P \to P_k} (P - P_k) \cdot F(P);$$

Tok tasvirining mahrajini nolga tenglashtirib, uning ildizlarini aniqlaymiz va tok originalini topamiz:

$F_2=12\cdot10^6p+1{,}75\cdot10^9=0$ $p_i = -\frac{1{,}75 \cdot 10^9}{12 \cdot 10^6} = -146 \quad c^{-1}$; $i_c(t) = A \cdot e^{P_i t} = \frac{F_1(P_1)}{F_2^1(P_1)} \cdot e^{P_i t}$;

$F_1(p)= -60\cdot10^3$; $F_1(p_1)= -60\cdot10^3$; $F_2(p)=12\cdot10^6p+1{,}75\cdot10^9$; $F_2'(p)=12\cdot10^6$;

$$i_c(t) = \frac{-60 \cdot 10^3}{12 \cdot 10^6} \cdot e^{-146 t} = -5 \cdot 10^{-3} \cdot e^{-146 t} (A);$$

$$i_c(t) = -5 \cdot 10^{-3} \cdot e^{-146 t} A$$

$$U_C(P) = \frac{240 \cdot 10^6 p + 20 \cdot 10^9}{p(12 \cdot 10^6 p + 1{,}75 \cdot 10^9)} = \frac{F_3(p)}{p \cdot F_2(p)} = U_c(t) = \frac{F_3(0)}{F_2(0)} + \frac{F_3(Pk)}{Pk \cdot F_2'(Pk)} \cdot e^{Pkt}$$

Kuchlanish tasvirining mahrajini nolga tenglashtirib uning ildizlarini va kuchlanish originali ifodasini topamiz:

$$p \cdot F_2(p) = p(12 \cdot 10^6 p + 1{,}75 \cdot 10^9) = 0; \qquad p_0 = 0; \quad p_1 = -146 \quad c^{-1};$$

$$F_3(p) = 240 \cdot 10^6 p + 20 \cdot 10^9; \quad F_3(0) = 20 \cdot 10^9$$

$$F_3(P_1) = 240 \cdot 10^6 p_1 + 20 \cdot 10^9 = 240 \cdot 10 \cdot (-146) + 20 \cdot 10^9 = -15 \cdot 10^9;$$

$$F_2(P) = 12 \cdot 10^6 p + 1{,}75 \cdot 10^9; \quad F_2(0) = 1{,}75 \cdot 10^9;$$

$$P_1 \cdot F_2'(P_1 = -146 \cdot 12 \cdot 10^6 = -1{,}75 \cdot 10^9)$$

$$U_c(t) = \frac{20 \cdot 10^9}{1{,}75 \cdot 10^9} + \frac{-15 \cdot 10^9}{-1{,}75 \cdot 10^9} \cdot e^{-146 t} = 11{,}42 + 8{,}58 \cdot e^{-146 t} (B)$$

$$U_c(t) = 11{,}42 + 8{,}58 \cdot e^{-146 t} (B)$$

O'tish toki va kuchlanishining topilgan qiymatlari, klassik usulda hisoblab topilgan qiymatlar bilan mos keldi.