ELEKTR TA'MINOTI TIZIMI TARMOG'INING REAKTIV QUVVAT TOKLARINI ELEKTROMAGNIT QURILMALARI NOSIMMETRIK JARAYONLARNI MODELLASHTIRISH

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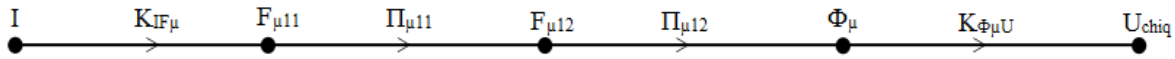
ABSTRACT

Ushbu maqolada gibrid energiya manbali elektr ta'minoti tizimi tarmoqlarida reaktiv quvvat toklarining elektromagnit qurilmalari uchun yuqori aniqlikni ta'minlovchi birlamchi nosimmetrik jarayonlarni yig'ilgan va tarqoq parametrli graf modellari hamda analitik ifodalari yordamida modellashtirish amalga oshirilgan.

Asosiy qisim. Elektr ta'minoti tarmoqlaridan (ETT) oqayotgan uch fazali birlamchi toklarni ikkilamchi kuchlanish, signal ko'rinishiga o'zgartirishda signal o'zgartirish tamoyili mavjud. Jumladan NIUFTO'Qlarda uchta oddiy o'lchovli cho'lg'am yoki yassi o'lchovli cho'lg'am qo'llanilganda birlamchi toklar, o'zgartirish zanjiri yoki tuzilmasi uning geometrik shakli va o'lchamlari hamda qo'llanilgan signal o'zgartirish tamoyili fizik –texnik effekt asosidagi quyidagi algoritmlar asosida tadqiq etiladi:

a) ETTT reaktiv quvvat manbasi ulangan neytrali izolatsiyalangan uch fazali reaktiv quvvat tok elektr tarmog'ining yig'ilgan parametrli bir fazali bitta sezgir elementli qurilmasining ikkilamchi kuchlanishini hosil qilish graf modeli shakllantirilgan (1- rasm).



1-rasm. Neytrali izolatsiyalangan uch fazali tok o'zgartkich qurilmasining ikkilamchi kuchlanishini hosil qilishning yig'ilgan parametrli graf modeli

ETTT reaktiv quvvat manbasi elektr tarmog'ining yig'ilgan parametrli bir fazali bitta sezgir elementli NIUFTO'Qning chiqish kuchlanishini hosil qilish graf modeli asosida shakllantirilgan analitik ifoda (1) ko'rinishida bo'ladi [2, 9]:

$$U_{chiq} = W_{IU_{chiq}}(IU_{chiq})I = K_{IF_\mu}\Pi_\mu K_{\Phi_\mu U_{chiq}} I = (4.44 f w_2 w_1/R_\mu)I, \quad (1)$$

bu yerda: $W_{IU_{chiq}}(IU_{chiq}) = K_{IF_\mu}\Pi_\mu K_{\Phi_\mu U_{chiq}}$ – birlamchi tok I ni ikkilamchi kuchlanish U_{chiq} ga o'zgartirish bo'lagi orqali uzatish funktsiyasi;

K_{IF_μ} – birlamchi tokni m.yu.k.ga zanjirlar aro o'zgartirish koeffitsienti [1];

$K_{\Phi_\mu U_{chiq}}$ – magnit oqimini kuchlanishga zanjirlar-aro o'zgartirish koeffitsienti;

I – elektr tarmog'ining birlamchi toki;

f - elektr tarmog'ining tok chastotasi;

w_2,w_1 – NIUFTO'Q birlamchi va ikkilamchi chulg'amlarining o'ramlari soni;

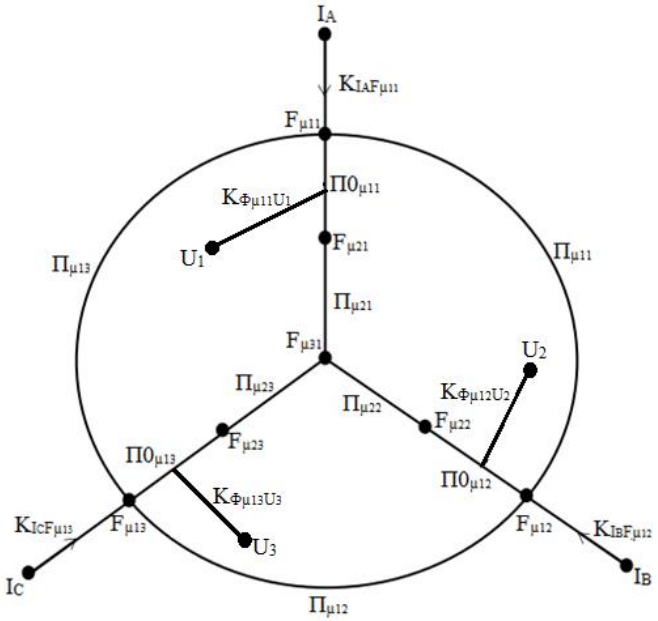
$\Pi_\mu = R_\mu - \frac{\rho L}{F}$ - signal o‘zgartirish bo‘lagi (magnit) qarshiligi;

ρ - magnit o‘zak materialining solishtirma qarshiligi;

L – magnit oqimining yo‘li uzunligi;

F – magnit o‘zak yuzasi geometrik o‘lchami.

b) ETTT reaktiv quvvat manbasi ulangan neytrali izolatsiyalangan uch fazali reaktiv quvvat tok elektr tarmog‘ining tarqoq parametrli uch fazali uchta sezgir elementli NIUFTO‘Q ikkilamchi kuchlanishini hosil qilingan graf modeli shakllantirilgan (2- rasm).



2-rasm. Neytrali iziolyatsiyalangan uch fazali tok o‘zgartkich qurilmasining ikkilamchi kuchlanishini hosil qilishning tarqoq parametrli graf modeli

Tarqoq parametrli uch fazali uchta sezgir elementli NIUFTO‘Qning graf modeli asosida chiqish kuchlanishini shakllantirish uchun toklar orqali m.yu.k larni hosil qilingan analitik ifoda (2) ko‘rinishlarida bo‘ladi [8, 9]:

$$\begin{cases} \frac{F_{\mu11}-F_{\mu12}}{\Pi_{\mu11}} + \frac{F_{\mu11}-F_{\mu21}}{\Pi 0_{\mu11}} + \frac{F_{\mu11}-F_{\mu13}}{\Pi_{\mu13}} = K_{I_A F_{\mu11}} I_A; \\ \frac{F_{\mu21}-F_{\mu11}}{\Pi 0_{\mu11}} + \frac{F_{\mu21}-F_{\mu31}}{\Pi_{\mu21}} = 0; \\ \frac{F_{\mu12}-F_{\mu11}}{\Pi_{\mu11}} + \frac{F_{\mu12}-F_{\mu22}}{\Pi 0_{\mu12}} + \frac{F_{\mu12}-F_{\mu13}}{\Pi_{\mu12}} = K_{I_B F_{\mu12}} I_B \\ \frac{F_{\mu22}-F_{\mu12}}{\Pi O_{\mu12}} + \frac{F_{\mu22}-F_{\mu31}}{\Pi_{\mu22}} = 0; \\ \frac{F_{\mu13}-F_{\mu12}}{\Pi_{\mu12}} + \frac{F_{\mu13}-F_{\mu22}}{\Pi 0_{\mu13}} + \frac{F_{\mu13}-F_{\mu11}}{\Pi_{\mu13}} = K_{I_C F_{\mu13}} I_C \\ \frac{F_{\mu23}-F_{\mu13}}{\Pi 0_{\mu13}} + \frac{F_{\mu28}-F_{\mu13}}{\Pi_{\mu23}} = 0; \\ \frac{F_{\mu31}-F_{\mu21}}{\Pi_{\mu21}} + \frac{F_{\mu31}-F_{\mu22}}{\Pi_{\mu22}} + \frac{F_{\mu31}-F_{\mu23}}{\Pi_{\mu23}} = 0. \end{cases} \quad (2)$$

Bu yerda: Sezgir element o‘ramlari soniga bog‘liq koeffitsientlar (w_a, w_b, w_c) - $K_{I_A F_{\mu11}}$, $K_{I_B F_{\mu12}}$, $K_{I_C F_{\mu13}}$; birlamchi toklar- I_A, I_B, I_C; magnit o‘zak (sterjen) va havo oraliq magnit parametrlari qarshiliklari - Π_{ij}, $\Pi O_{\mu ij}$; qurilma magnit o‘zagidagi (sterjen) m.yu.k. lar - $F_{\mu i,j}$.

Hosil qilingan yetti noma'lumli tenglamalar tizimidan, noma'lumlar bo'lgan m.yu.k.lar magnit o'zgartirish bo'lagida tarqalishi magnit parametrlarga mos ravishda aniqlanadi va m.yu.k.larning qiymatlari uzatish funktsiyalari miqdorlarini belgilaydi.

Birlamchi elektr toklari - I_A, I_B, I_C, m.yu.k. - $F_{\mu 11}$, $F_{\mu 12}$, $F_{\mu 13}$, magnit oqimlari - $\Phi_{\mu 11}$, $\Phi_{\mu 12}$, $\Phi_{\mu 13}$ va chiqish ikkilamchi kuchlanishlariga – U_1, U_2, U_3, o'zgartirish jarayonidagi bog'liqliklarning analitik ifodalari (3), (4) va (5) shakllantiriladi:

$$U_1 = К_{\Phi_{\mu 11} U_1} \Phi_{\mu 11}; \quad (3)$$

$$\Phi_{\mu 11} = \frac{F_{\mu 11} - F_{\mu 21}}{ПО_{\mu 11}};$$

$$F_{\mu_{11}} = К_{I_A F_{\mu 11}} I_A.$$

$$U_2 = К_{\Phi_{\mu 12} U_2} \Phi_{\mu 12}; \quad (4)$$

$$\Phi_{\mu 12} = \frac{F_{\mu 12} - F_{\mu 22}}{ПО_{\mu 12}};$$

$$F_{\mu 12} = К_{I_B F_{\mu 12}} I_B.$$

$$U_3 = К_{\Phi_{\mu 13} U_3} \Phi_{\mu 13}; \quad (5)$$

$$\Phi_{\mu 13} = \frac{F_{\mu 13} - F_{\mu 23}}{ПО_{\mu 13}};$$

$$F_{\mu 13} = К_{I_C F_{\mu 13}} I_C.$$

Yuqoridagi ifodadan foydalanib m.yu.k. lar hosil qilingan magnit oqimlari orqali quyidagicha (6), (7) va (8) ikkilamchi kuchlanishlarini hosil qilish mumkin.

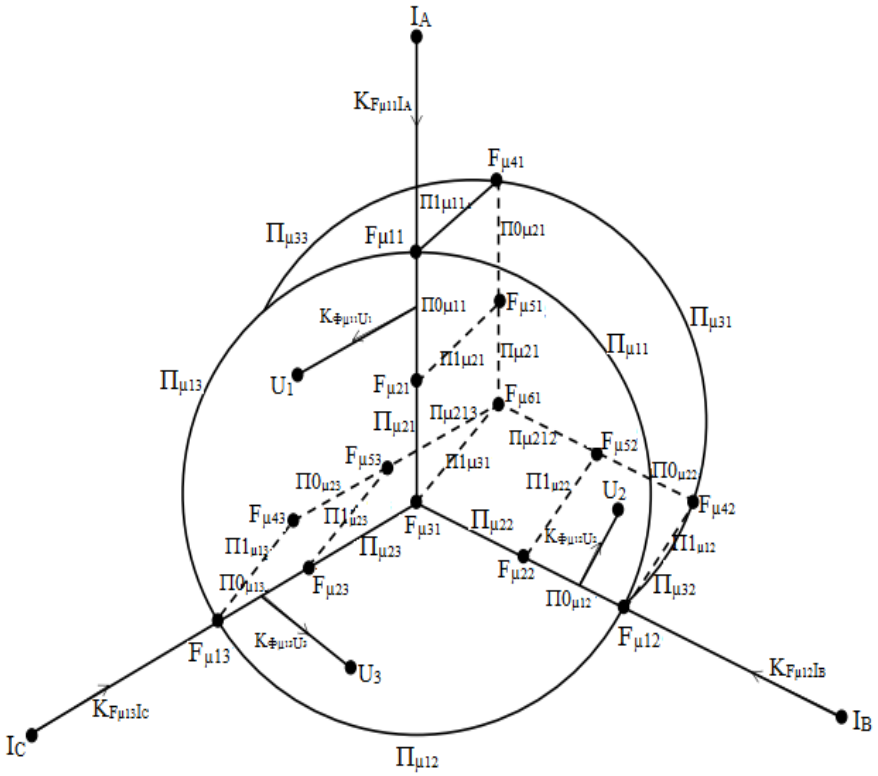
$$U_1 = К_{\Phi_{\mu 11} U1} \left(\frac{К_{I_A F_{\mu 11}}}{ПО_{\mu 11}} I_A - \frac{F_{\mu 21}}{ПО_{\mu 11}} \right); \quad (6)$$

$$U_2 = К_{\Phi_{\mu 12} U_2} \left(\frac{К_{I_A F_{\mu 12}}}{ПО_{\mu 12}} I_B - \frac{F_{\mu 22}}{ПО_{\mu 12}} \right); \quad (7)$$

$$U_3 = К_{\Phi_{\mu 13} U_3} \left(\frac{К_{I_C F_{\mu 13}}}{ПО_{\mu 13}} I_C - \frac{F_{\mu 23}}{ПО_{\mu 13}} \right); \quad (8)$$

bu yerda: "$К_{\Phi_{\mu 11} Ua}$, $К_{\Phi_{\mu 12} U_b}$, $К_{\Phi_{\mu 13} U_c}$ - Ikkilamchi chiqish kuchlanish va magnit oqimlarning o'zaro bog'liqlik koeffitsienti" [2-7].

c) GEMli neytrali izolatsiyalangan uch fazali elektr tarmog'iga reaktiv quvvat manbasi ulangan hajmsimon tarqoq parametrli uch fazali uchta sezgir elementli qurilmaning ikkilamchi kuchlanishini hosil qiliuvchi graf modeli shakllantirilgan (3- rasm).



3- rasm. Neytrali izolyatsiyalangan uch fazali tok o‘zgartkich qurilmasining ikkilamchi kuchlanishini hosil qilishning hajmsimon tarqoq parametrli graf modeli

Hajmsimon tarqoq parametrli uch fazali uchta sezgir elementli NIUFTO‘Qning graf modeli asosida chiqish kuchlanishini shakllantirish uchun toklar orqali m.yu.k larni hosil qilingan analitik ifoda (9) ko‘rinishlarida bo‘ladi [6]:

$$\begin{cases} \frac{F_{\mu 11}-F_{\mu 12}}{\Pi_{\mu 11}}+\frac{F_{\mu 11}-F_{\mu 121}}{\Pi 0_{\mu 11}}+\frac{F_{\mu 11}-F_{\mu 13}}{\Pi_{\mu 13}}+\frac{F_{\mu 11}-F_{\mu 41}}{\Pi 1_{\mu 11}}=K_{I_A F_{\mu 111}} I_A; \\ \frac{F_{\mu 21}-F_{\mu 11}}{\Pi 0_{\mu 11}}+\frac{F_{\mu 21}-F_{\mu 31}}{\Pi_{\mu 21}}+\frac{F_{\mu 21}-F_{\mu 51}}{\Pi 1_{\mu 21}}=0; \\ \frac{F_{\mu 12}-F_{\mu 11}}{\Pi_{\mu 11}}+\frac{F_{\mu 12}-F_{\mu 22}}{\Pi 0_{\mu 12}}+\frac{F_{\mu 12}-F_{\mu 13}}{\Pi_{\mu 12}}+\frac{F_{\mu 12}-F_{\mu 42}}{\Pi 1_{\mu 12}}=K_{I_B F_{\mu 12}} I_B; \\ \frac{F_{\mu 22}-F_{\mu 12}}{\Pi O_{\mu 12}}+\frac{F_{\mu 22}-F_{\mu 31}}{\Pi_{\mu 22}}+\frac{F_{\mu 22}-F_{\mu 52}}{\Pi 1_{\mu 22}}=0; \\ \frac{F_{\mu 13}-F_{\mu 12}}{\Pi_{\mu 12}}+\frac{F_{\mu 13}-F_{\mu 22}}{\Pi 0_{\mu 13}}+\frac{F_{\mu 13}-F_{\mu 11}}{\Pi_{\mu 13}}+\frac{F_{\mu 13}-F_{\mu 43}}{\Pi 1_{\mu 13}}=K_{I_C F_{\mu 13}} I_C; \\ \frac{F_{\mu 23}-F_{\mu 13}}{\Pi 0_{\mu 13}}+\frac{F_{\mu 28}-F_{\mu 13}}{\Pi_{\mu 23}}+\frac{F_{\mu 23}-F_{\mu 53}}{\Pi 1_{\mu 23}}=0; \\ \frac{F_{\mu 31}-F_{\mu 21}}{\Pi_{\mu 21}}+\frac{F_{\mu 31}-F_{\mu 22}}{\Pi_{\mu 22}}+\frac{F_{\mu 31}-F_{\mu 23}}{\Pi_{\mu 23}}+\frac{F_{\mu 31}-F_{\mu 61}}{\Pi 1_{\mu 31}}=0. \end{cases} \quad (9)$$

Birlamchi elektr toklari - I_A, I_B, I_C, m.yu.k. - $F_{\mu 11}$, $F_{\mu 12}$, $F_{\mu 13}$, magnit oqimlari - $\Phi_{\mu 11}$, $\Phi_{\mu 12}$, $\Phi_{\mu 13}$ va chiqish ikkilamchi kuchlanishlariga – U_1, U_2, U_3, o‘zgartirish jarayonidagi bog‘liqliklarning analitik ifodalari (10), (11) va (12) shakllantiriladi:

$$U_1 = K_{\Phi_{\mu 11} U_1} \Phi_{\mu 11}; \quad (10)$$

$$\Phi_{\mu 11} = \frac{F_{\mu 11} - F_{\mu 21}}{\Pi O_{\mu 11}} + \frac{F_{\mu 11} - F_{\mu 41}}{\Pi 1_{\mu 11}};$$

$$F_{\mu_{11}} = K_{I_A F_{\mu 11}} I_A.$$

$$U_2 = K_{\Phi_{\mu 12} U_2} \Phi_{\mu 12}; \quad (11)$$

$$\Phi_{\mu 12} = \frac{F_{\mu 12} - F_{\mu 22}}{\Pi O_{\mu 12}} + \frac{F_{\mu 12} - F_{\mu 42}}{\Pi 1_{\mu 12}};$$

$$F_{\mu 12} = K_{I_B F_{\mu 12}} I_B.$$

$$U_3 = K_{\Phi_{\mu 13} U_3} \Phi_{\mu 13}; \quad (12)$$

$$\Phi_{\mu 13} = \frac{F_{\mu 13} - F_{\mu 23}}{\Pi O_{\mu 13}} + \frac{F_{\mu 13} - F_{\mu 43}}{\Pi 1_{\mu 13}};$$

$$F_{\mu 13} = K_{I_C F_{\mu 13}} I_C.$$

Yuqoridagi ifodadan foydalanib m.yu.k. lar hosil qilingan magnit oqimlari orqali quyidagicha (13), (14) va (15) ikkilamchi kuchlanishlarini hosil qilish mumkin.

$$U_1 = K_{\Phi_{\mu 11} U1} \left(\frac{K_{I_A F_{\mu 11}}}{\Pi O_{\mu 11}} I_A - \frac{F_{\mu 21}}{\Pi O_{\mu 11}} - \frac{F_{\mu 41}}{\Pi 1_{\mu 11}} \right); \quad (13)$$

$$U_2 = K_{\Phi_{\mu 12} U_2} \left(\frac{K_{I_A F_{\mu 12}}}{\Pi O_{\mu 12}} I_B - \frac{F_{\mu 22}}{\Pi O_{\mu 12}} - \frac{F_{\mu 42}}{\Pi 1_{\mu 12}} \right); \quad (14)$$

$$U_3 = K_{\Phi_{\mu 13} U_3} \left(\frac{K_{I_C F_{\mu 13}}}{\Pi O_{\mu 13}} I_C - \frac{F_{\mu 23}}{\Pi O_{\mu 13}} - \frac{F_{\mu 43}}{\Pi 1_{\mu 13}} \right); \quad (15)$$

Xulosa. Yuqoridagi formulalardan ko‘rinib turibdiki hosil qilingan magnit yurituvchi kuchlar orqali va nosimmetrik holatda m.yu.k. hosil qilgan magnit maydonga kiritilgan sezgir element (yassi plastinkaga o‘ralgan chulg‘am) sezish diapazonida ikkilamchi chiqish kuchlanishini olishimiz mumkin. Agar nosimmetrik holat yuz bermasa ya’ni fazalar aro simmetriya bo‘lsa bu holatda ikkilamchi chiqish kuchlanishi nolga teng bo‘ladi.

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