ELEKTR TA'MINOTI VA QAYTA TIKLANUVCHAN ENERGIYA MANBALARI KAFEDRASI

FAN: ЎТКИНЧИ ЖАРАЁНЛАР

ТЕМА 06

НОМЛАНГАН КАТТАЛИКЛАРНИ АНИҚ ҲИСОБЛАШ

БАБАЕВ АЗИЗ ГАЛИБОВИЧ

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Adabiyotlar:

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NOMLI BIRLIKLARDA ANIQ KELTIRISH

Qisqa tutashuv toklar hisobi.

Masala. Berilgan energosistema sxemasi uchun (5.1rasm) nisbiy va nomli birliklarda aniq va taxminiy keltirishlarni amalga oshiring.

Generator dastlab nominal kuchlanishda salt ishlab turgan deb hisoblab uch fazali qisqa tutashuvdagi o'ta o'tkinchi tokni hisoblang.
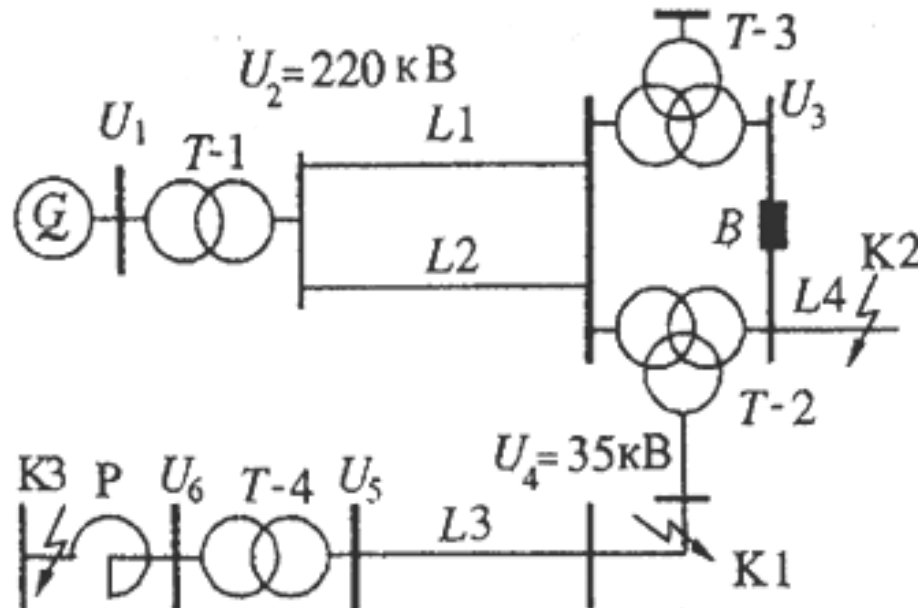
5.1-rasm. ES ning sxemasi (5.1 masala uchun)

Sxema elementlarining parametrlari :

Generator G: $S_{nom}=176,5$ MB A, $U_{nom}=15,75$ kV, $x''_d=0,5$.

Transformator T-1: $S_{nom}=180$ MVA, 242/15,5 kV, $U_K= 12$ %. Transformatorlar

T-2, T-3: $S_{nom}= 90$ MBA, 220/38,5/11 kV, $U_{vs}=12$ %,

$U_{vn}=20\%$, $U_{sn}= 8\%$.

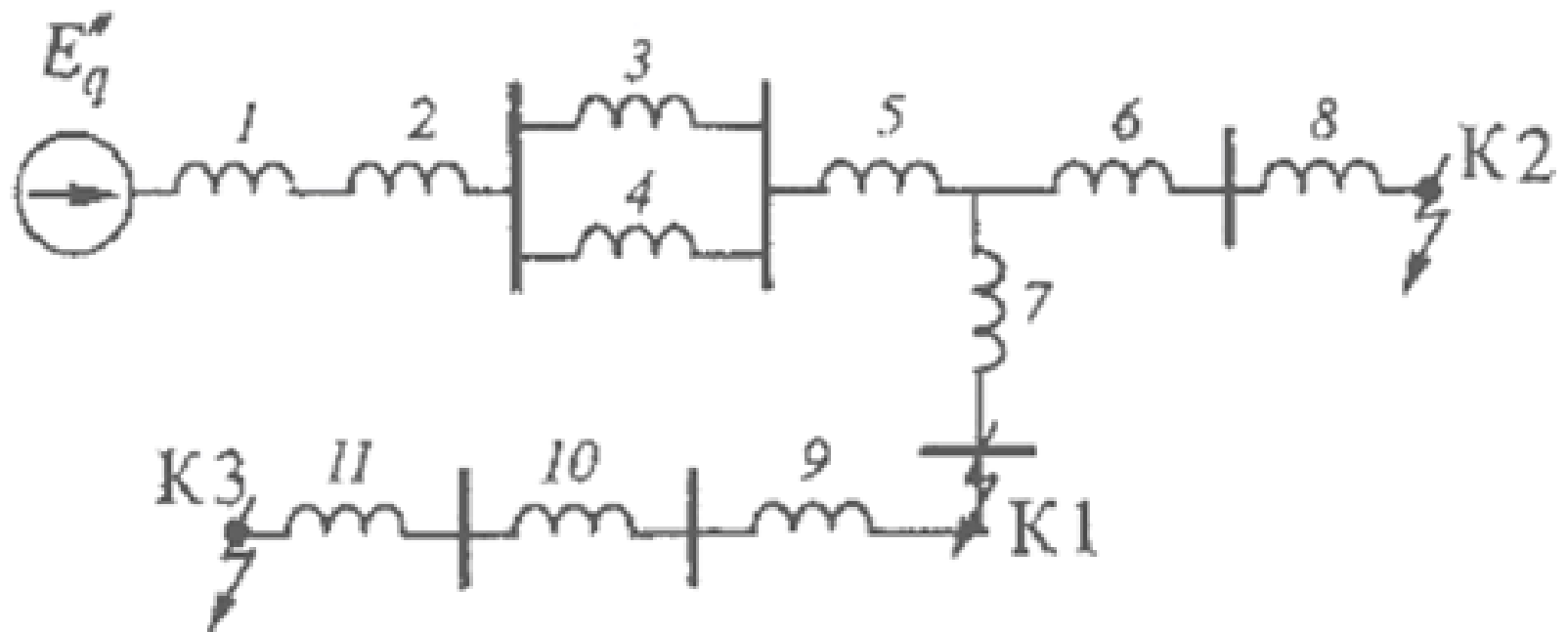Transformator T-4: $S_{nom}= 60$ MBA, 35/6,6 kV, $U_K =10,5$ %.

Liniya L1, L2: $l = 110$ km, $x_o =0,4$ Om/km.

Liniya L3: $l = 30$ km, $x_o = 0,4$ Om/km.

Liniya L4 (kabel): $l = 2,5$ km, $x_o= 0,08$ Om/km.

Reaktor: $U_{nom} = 6$kV, $I_{nom}= 500$A, $x = 5$ %.

Hisoblash sxemasi .

5.2.rasm . 5.1. masalasini echish uchun xisobiy almashtirish sxemasi .

Nomli birliklarda aniq keltirish

T-**1** transformatorning yuqori kuchlanishli shinasi kuchlanishining asosiy pog'onasi U_{osn}=**220** kV qabul qilamiz.Transformatorning haqiqiy transformatsiyasi koeffitsientini hisobga olib reaktiv qarshiliklarning keltirilgan qiymatlari uchun quyidagiga ega bo'lamiz:

$$x_1 = x''_d(U^2_{nom}/S_{nom})(k_{r1})^2 = 0.15(15.75/176.5)(242/15.75)^2 = 49.8 \text{ Om},$$

$$x_2 = (U_K\%/100)(U^2_{nom}/S_{nom}) = (12/100)(242^2/180) = 39 \text{ Om},$$

$$x_3 = x_4 = x_0 l_1 = 0.4 \cdot 110 = 44 \text{ Om},$$

$$x_5 = (U_{Kv}/100)(U^2_{nom}/S_{nom}) = (12/100)(220^2/90) = 64.5 \text{ Om},$$

bu erda $U_{Kv} = 0.5(U_{Kv-s} + U_{Kv-n} - U_{Ks-n}) = 0.5(12+20-8) = 12\%$,

$$x_6 = (U_{Kn}/100)(U^2_{nom}/S_{nom}) = (8/100)(220^2/90) = 43 \text{ Om},$$

bu erda $U_{Kn} = 0.5(U_{Kv-n} + U_{Ks-n} - U_{Kv-s}) = 0.5(20+8-12) = 8\%$,

$$x_7 = (U_{Ks}/100)(U^2_{nom}/S_{nom}) = 0,$$

bu erda $U_{Ks} = 0$,

$$x_8 = x_0 l_4 (k_{r2})^2 = 0.08 \cdot 2.5 (220/11)^2 = 80 \text{ Om},$$

$$x_9 = x_0 l_3 (k_{r2})^2 = 0.4 \cdot 30 (220/38.5)^2 = 392 \text{ Om},$$

$$x_{10} = (U_K \%/100)(U^2_{nom4}/S_{nom4})(k_{r2})^2 = (10.5/100)(35^2/60)(220/38.5)^2 = 70 \text{ Om},$$

$$x_{11} = (x_P \%/100)(U_{nom}/3^{0,5} I_{nom})(k_{r4} k_{r2}) =$$

$$= (5/100)(6/3^{0,5} \cdot 0.5)[(35/6.6)(220/38.5)]^2 = 318 \text{ Om}.$$

Generator EYUK ning faza qiymati :

$$E''_q = U_{nom} k_{r1} = 15.75(242/3^{0,5} \cdot 15.75) = 242/3^{0,5} = 139.8 \text{ kV}.$$

K1 nuqtada boshlangich o'ta o'tkinchi tok:

$$I''_{K1} = E''_q / x_{1\Sigma} = 139.8/175.3 = 0.79 \text{ kA},$$

bu erda $x_{1\Sigma} = x_1 + x_2 + x_3 // x_4 + x_5 + x_7 = 175.3$ Om.

KZ pog'onasiga (38,5 kV) keltirilgan tok:

$$\bar{I}''_{K1} = I''_{K1}(1/k'_{r2}) = 0.79(220/38.5) = 4.5 \text{ kA},$$

K2 uchun:

$$I''_{K2}=E''_q/ x_{2\Sigma} =139.8/298.3=0.47 \text{ kA},$$

bu erda $x_{2\Sigma}=x_1+x_2+x_3//x_4+x_5+x_6+x_8=298.3$ Om.

KZ pog'onasiga (11 kV) keltirilgan tok:

$$\bar{I}''_{K2}= I''_{K2}(1/k'_{r2})=0.47(220/11)=9.4 \text{ kA},$$

K3 uchun:

$$I''_{K3}=E''_q/ x_{3\Sigma} =139.8/955.3=0.146 \text{ kA},$$

bu erda $x_{3\Sigma}=x_1+x_2+x_3//x_4+x_5+x_7+x_9+x_{10}+x_{11}=955.3$ Om.

KZ pog'onasiga (6,6 kV) keltirilgan tok:

$$\bar{I}''_{K3}= I''_{K3}(1/k''_{r2})(1/ k'_{r4})=0.146(220/38.5)(35/6.6)=4.4 \text{ kA},$$

Nomli birliklarda taxminiy keltirish

O'rnatilgan shkala bo'yicha transformatsiyalash pog'onalari nominal kuchlanishning o'rtacha miqdori :

U_1=15,75 kV, U_2=230 kV, U_3=10..5 kV, U_4=37 kV, U_6=6.3 kV.

230 kV kuchlanish pog'onasiga keltirish qarshilikning quyidagi qiymatlarini beradi:

$$x_1=0,15(230^2/176.5)=45 \text{ Om}, \quad x_2=(12/100)(230^2/180)=35.4 \text{ Om},$$

$$x_3=x_4=0.4 \cdot 100=44 \text{ Om},$$

$$x_5=(12/100)(230^2/90)=70.7 \text{ Om}, \quad x_6=(8/100)(230^2/90)=47.1 \text{ Om},$$

$$x_7=0, \quad x_8=0.08 \cdot 2.5(230^2/90)=96 \text{ Om},$$

$$x_9=0.4 \cdot 30(230^2/37)=463 \text{ Om}, \quad x_{10}=(10.5/100)(37^2/60)(230/37)^2=$$

$$=92.6 \text{ Om},$$

$$x_{11}=(5/100)(6/3^{0,5} \cdot 0.5)(230/6.3)^2 =464 \text{ Om}.$$

Generator EYUK ining faza qiymati :

$$E''_q=15.75(230/3^{0.5}\cdot15.75)=132.5 \text{ kV.}$$

K1 nuqtada boshlang'ich tok ;

$$I''_{K1}=132.5/173.1=0.76 \text{ kA,}$$

bu erda $x_{\Sigma 1}=45+35.4+(44/2)+70.7=173.1$ Om.

KZ (37 kV) pog'onasiga keltirilgan tok :

$$\bar{I}''_{K1}=0.76(230/37)=4.72 \text{ kA,}$$

K2 nuqtada

$$\bar{I}''_{K2}=132.5/316.2=0.42 \text{ kA,}$$

bu erda $x_{\Sigma 2}=45+35.4+(44/2)+70.7+47.1+96=316.2$ Om.

KZ (10,5 kV) pog'onasiga keltirilgan tok:

$$\bar{I}''_{K2}=0.42(230/10.5)=9.18 \text{ kA,}$$

KZ nuqtada

$$\bar{I}''_{K3}=132.5/1192.7=0.11 \text{ kA,}$$

bu erda $x_{\Sigma 3}=45+35.4+(44/2)+70.7+463+92.6+464=1192.7$ Om.

KZ (6,3 kV) pog'onasiga keltirilgan tok:

$$\bar{I}''_{K3}=0.11(230/6.3)=4.06 \text{ kA.}$$

Nisbiy birliklarda aniq keltirish .

Bazis quvvat sifatida S_6= 1000 MVA,bazis kuchlanishi sifatida $-$ U_{61}= 220 kV. qabul qilamiz: Kuchlanishning boshqa pog'onalarida bazis kuchlanish quyidagidek bo'ladi ;

$$U_{62}=U_{61}/k_{r1}=220(15.75/242)=14.3 \text{ kV},$$
$$U_{63}=U_{61}/k_{r2S}=220(38.5/220)=38.5 \text{ kV},$$
$$U_{64}=U_{61}/k_{r2N}=220/11/220)=11 \text{ kV},$$
$$U_{65}=U_{61}/k_{r1}k_{r3}=220(38.5/220)(6.6/35)=7.26 \text{ kV}.$$

KZ pog'onasidagi bazis toklar miqdori :

$$I_{63}=S_6/3^{0,5}U_{63}=1000/3^{0,5}\cdot38.5=15\,\text{kA},$$
$$I_{64}= S_6/3^{0,5}U_{64}=1000/3^{0,5}\cdot11=52.5\,\text{kA},$$
$$I_{65}= S_6/3^{0,5}U_{65}=1000/3^{0,5}\cdot7.26 = 79.5 \text{ kA},$$

Reaktiv qarshiliklarning nisbiy kattaliklari :

$$x_1 =x''_d(S_6/S_{nom})(U_{nom}/U_{62})^2=0.15(1000/176.5)(15.75/14.3)^2=1.03,$$
$$x_2=(U_K\%/100)(S_6/S_{nom})(U_n/U_{61})^2=0.81,$$
$$x_3=x_4=x_0l_1(S_6/U^2_{61})=0.4\cdot110(1000/220^2=0.91,$$
$$x_5=(U_{Kv}\%/100)(S_6/S_{nom})(U_{nom}/U_{61})^2=(12/100)(1000/90)=1.33,$$
$$x_6=(U_{Kn}\%/100)(S_6/S_{nom})(U_{nom}/U_{61})^2=(8/100)(1000/90)=0.89,$$
$$x_7= 0, \ x_8=x_0l_4(S_6/U^2_{64})=0.08\cdot2.5(1000/11^2)=1.65,$$
$$x_9= x_0l_3 \ (S_6/U^2_{63})=0.4\cdot30(1000/38.5^2)=8.1,$$
$$x_{10}=(U_K\%/100)(S_6/S_{nom})(U_{nom}/U_{63})^2=(10.5/100)(1000/60)=1.45,$$
$$x_{11}=(x_r\%/100)(I_{65}/I_{nom})(U_n/U_{65})=(5/100)(79.5/0.5)(6/7.26)=6.56.$$

EYUK nisbiy kattaligi :

$$E''_q = 15.75/14.3 = 1.1.$$

K1 nuqtada boshlangich o'tkinchi tok ;

$$I''_{K1} = E''_q/x_{\Sigma 1} = 1.1/3.62 = 0.3,$$

bu erda $x_{\Sigma 1} = 1.03 + 0.81 + (0.1/2) + 1.33 = 3.62.$

KZ dagi nomli tok miqdori;

$$I''_{K1} = I''_{K1} I_{63} = 0.3 \cdot 15 = 4.5 \text{ kA},$$

K2 uchun

$$I''_{K2} = E''_q/x_{\Sigma 2} = 1.1/6.16 = 0.18,$$

Bu erda $x_{\Sigma 2} = 1.03 + 0.81 + (0.91/2) + 1.33 + 0.89 + 1.65 = 6.16.$

Nomli birliklarda tok miqdori :

$$I''_{K2} = I''_{K2} I_{64} = 0.18 \cdot 52.5 = 9.4 \text{ kA},$$

KZ nuqtadagi tokning nomli birliklardagi miqdori :

$$I''_{KZ} = E''_q/ x_{\Sigma 3} = 1.1/19.73 = 0.056,$$

bu erda $x_{\Sigma 3} = 1.03 + 0.81 + (0.91/2) + 1.33 + 8.1 + 1.45 + 6.56 = 19.73.$

KZ nuqtadagi tokning nomli miqdori ;

$$I''_{KZ} = I''_{KZ} I_{65} = 0.056 \cdot 79.5 = 4.4 \text{ kA}.$$

Nisbiy birliklarda tarkibiy keltirish .

Tarqribiy keltirishda har bir kuchlanish o'sha bosqichning nominal kuchlanishlarning o'rtacha qiymatiga teng bo'ladi:

U_{61}=230 kV, U_{62}=15.75 kV, U_{63}=37 kV, U_{64}=10.5 kV, U_{65}=6.3 kV.

S_6=1000 MVA bo'lganida KZ pog'onalardagi bazis toklar qiymatlari quyidagiga hisoblanadi:

$$I_{63}=1000/3^{0,5}\cdot37=15.6\,kA, \qquad I_{64}=1000/3^{0,5}\cdot10.5=55\,kA,$$
$$I_{65}=1000/3^{0,5}\cdot6.3=91.5\ kA.$$

Bu xolda qarshiliklarni hisobi ancha soddalashadi:

$$x_1=x''_d(S_6/S_n)=0,15(1000/176.5)=0.85,\ x_2=(12/100)(1000/180)=0.67,$$
$$x_3=x_4=0.4\cdot110(1000/230^2),\quad x_5=(12/100)(1000/90)=1.33,$$
$$x_6=(8/100)(1000/90)=0.89,\ x_7=0,\ x_8=0.08\cdot2.5(1000/10.5)=1.82,$$
$$x_9=0.4\cdot30(1000/37^2)=8.8,\quad x_{10}=(10.5/100)(1000/60)=1.75,$$
$$x_{11}=(5/100)(91.5/0.5)(6/6.3)=8.7.$$

EYUK ning nisbiy kattaligi :

$$E''_q=15.75/15.75=1.$$

K1 oʻtkinchi boshlangich tok:

$$I''_{K1}=1/3.26=0.3,$$

Bu erda $x_{\Sigma1}=0.85+0.67+0.415+1.33=3.26.$

Tokning nomli kattaliklaridagi qiymati :

$$I''_{K1}=0.3\cdot15.6=4.8 \text{ kA, v tochke K2 } I''_{K2}=1/5.97=0.167,$$

bu erda $x_{\Sigma2}=0.85+0.67+0.415+1.33+0.89+1.82=5.97$; $I''_{K2}=0.167\cdot55=9.2\,kA,$

K3 nuqtada $I''_{K3}=1/22.5=0.044,$

bu erda $x_{\Sigma3}=0.85+0.67+0.415+1.33+8.8+1.75+8.7=22.5;$

$$I''_{KZ}=0.044\cdot91.5=4.1 \text{ kA.}$$

Elektr tok tarmogʻining   KZ (kA) nuqtada parametrlarni keltirib hisoblangan qisqa tutashuv toklarning, nomli va nisbiy birliklarda hisoblangan kattaliklari jadvalda keltirilgan.

Keltirilgan	K1		K2		K3	
Aniq	4.50	4.50	9.40	9.40	4.40	4.40
Taxminiy	4.72	4.80	9.12	9.20	4.06	4.1

E'TIBORINGIZ UCHUN RAHMAT!

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