ELEKTR ENERGETIKA TIZIMI HOLAT PARAMETRLARINI SUN'IY NEYRON TARMOQDAN FOYDALANIB BAHOLASH

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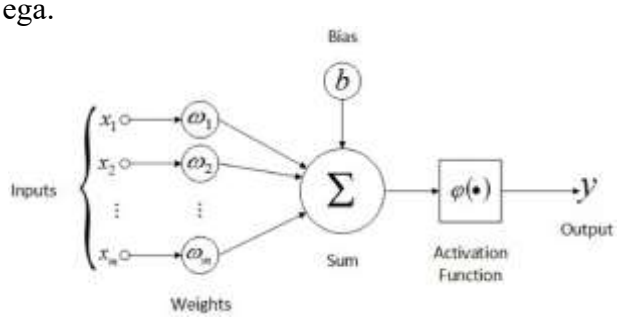
ANNOTATSIYA: Xozirda elektr energetika tizimlarini murakkablashishi natijasida ularni holatini tahlil etish murakkablashmoqda. Elektr energetika tizimi barqarorlashgan holatini modellashtirish nochiziqli tugun tenglamalari yordamida amalga oshiriladi va ularni yechish uchun odatda iteratsion usullar qo'llaniladi. Hozirgi kunda ushbu masalani yechishda sun'iy neyron tarmoqlar ham keng qo'llanilmoqda. Maqolada Nyuton – Rafson usuli va sun'iy neyron tarmoqdan foidalanib elektr energetik tizim barqaroqlashgan holati hisoblangan va olingan natijalar o'zaro solishtirilgan. Hisoblash besh tugunli elektr energetik tizim misolida ko'rib chiqilgan.

Kalit so'zlar: Elektr energetika tizimi, Nyuton-Raphson usuli, Gauss-Zaydel usuli, sun'iy neyron tarmoq, neyron, barqarorlashgan holat.

1. Kirish

Ma'lumki, insoning miyasi ko'plab neyronlardan iborat bo'lib, doimiy ravishda axborotlarni qayta ishlovchi o'ziga xos "hisoblovchi to'ri"dan iborat [1]. Neyron tarmoqlari inson miyasidagi neyronlarning kompyuterlashgan ko'rinishi bo'lib, har bir SNT bir biri bilan bog'langan va ma'lumotni qayta ishlovchi neyronlardan iborat. Tashqi ma'lumot ma'lumotlarini qabul qilib oluvchi neyronlar qatlami kirish neyronlari, tayyor natijalarni beruvchi neyronlar chiquvchi neyronlar deb ataladi. Oraliq neyronlari ichki yoki yashirin neyronlar deyiladi. Har bir neyronda bir nechta kirish bo'lib, faqat bitta chiqish bo'ladi. SNTlarning eng afzal tomoni ularni o'rgatish mumkinligidir, ya'ni chiquvchi signallar xatosini maqsadli ravishda eng kichik qiymatgacha kamaytirish mumkin [2].

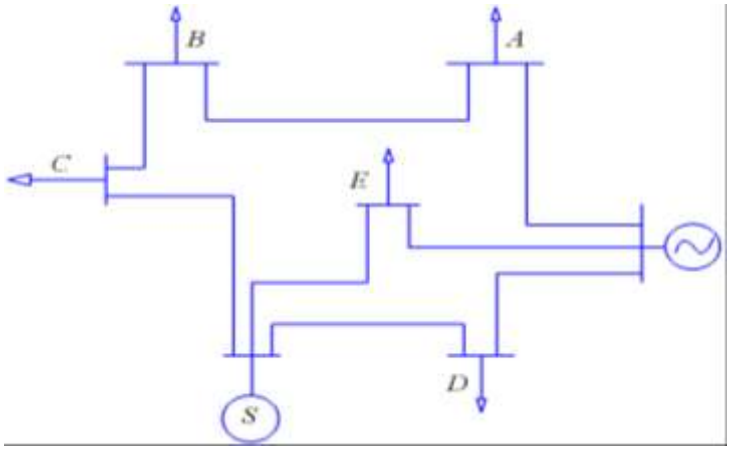
SNTning asosi bo'lib sun'iy neyron hisoblanadi (2-rasm) va u kirish, chiqish, faollashtirish funktsiyasi, summator va neyron siljishi (bias) dan iborat. Har bir kirish signali ma'lum bir "og'irlik"ga ega.



2-rasm. Sun'iy neyron modeli.

2. Nyuton – Rapson usulida elektr energetika tizimi holatini hisoblash

Elektr energetika tizimi holatini hisoblash uchun quyidagi sxemadan foydalanamiz (3-rasm). U beshta tugun, yuklama, bitta stansiya va cheksiz quvvat manbadan iborat.



3-rasm. Elektr energetika tizimi sxemasi

Yuklama bo'yicha ma'lumot 1-jadvalda, sxema bo'yicha ma'lumot esa 2-jadvalda keltirilgan.

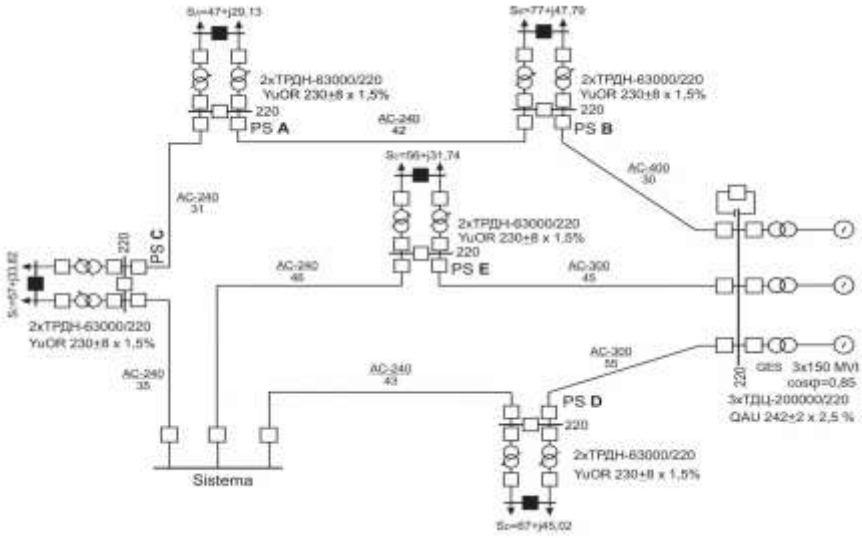
1-jadval. Shinalardagi yuklamalar.

	Shina A	Shina B	Shina C	Shina D	Shina E
P_1(Mvt)	52	70	79	76	68
P_2(Mvt)	50	68	67	74	66
P_3(Mvt)	48	66	65	72	64
P_4(Mvt)	66	62	59	68	60
P_5(Mvt)	63	79	87	85	76
Q_1(MVAr)	25,18472	33,90255	35,99335	41,02045	28,96789
Q_2(MVAr)	24,21608	32,93391	30,52601	39,94096	28,1159
Q_3(MVAr)	23,24744	31,96527	29,61479	38,86147	27,2639
Q_4(MVAr)	31,96523	30,02798	26,88113	36,7025	25,55991
Q_5(MVAr)	30,51228	38,26143	39,63831	45,87814	32,37587

2-jadval. Elektr energetika tizimi sxemasi bo'yicha ma'lumot.

EUL bosh - oh	U_n kV	EUL markasi	uzunligi, km	R_0 om	X_0 om	B_0*10^{-4} sim
G – B	220	AC-400	30	0.075	0.42	0.027
B – A	220	AC-240	42	0.121	0.435	0.026
A – C	220	AC-240	31	0.121	0.435	0.026
C – Sist	220	AC-240	35	0.121	0.435	0.026
G – E	220	AC-300	45	0.096	0.429	0.0264
E – Sist	220	AC-240	46	0.121	0.435	0.026
G – D	220	AC-300	55	0.096	0.429	0.0264
D – Sist	220	AC-240	43	0.121	0.435	0.026

Yuklama berilganda har bir tugundagi kuchlanish va uni og'ish burchagini aniqlash DIgSILENT PowerFactory dasturida Nyuton – Rapson usulidan foydalanib aniqlangan.



4-rasm. Tanlangan sxemaning prinsipial sxemasi.

Yuklamalar berilganda Nyuton – Rapson usulidan foydalanib shinalardagi kuchlanishlar va ularni og‘ish burchaklari 3 – jadvalda keltirilgan.

3 – jadval.

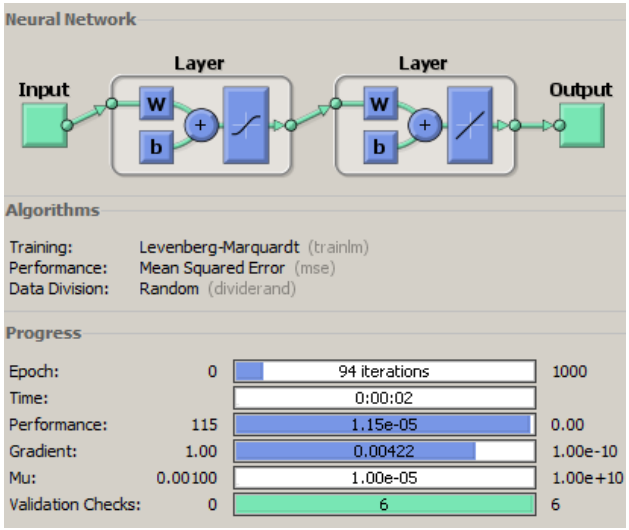
	Shina A	Shina B	Shina C	Shina D	Shina E
U_1(kV)	6,133828	5,930085	5,881859	6,018489	6,084519
U_2(kV)	6,151551	5,951327	5,909349	6,027073	6,092985
U_3(kV)	6,173292	5,972878	5,92486	6,040765	6,105939
U_4(kV)	6,129817	5,961082	5,92337	6,038003	6,10136
U_5(kV)	6,079519	5,879147	5,846624	5,986465	6,055647
U_{1phiu}(grad)	1,484291	-0,8926295	-1,657673	0,1138167	0,621181
U_{2phiu}(grad)	1,667045	-0,6632786	-1,286867	0,2119523	0,7245269
U_{3phiu} (grad)	1,908016	-0,4125734	-1,094695	0,3736177	0,8920599
U_{4phiu}(grad)	1,337883	-0,5388077	-1,091214	0,3423419	0,8485606
U_{5phiu}(grad)	0,8800856	-1,478829	-2,082702	-0,258953	0,2580654

3. Sun’iy neyron tarmogi asosida elektr energetika tizimi holatini hisoblash.

Sun’iy neyron tarmoqdan foydalanib elektr energetika tizimini tahlil qilishda [3] tashqi ma’lumotlarini ya’ni bizga berilgan elektr sxemasidagi har bir shinadagi oldingi 50ta aktiv reaktiv va yuklamalar (**P_A**, **P_B**, **P_C**, **P_D**, **P_E** va **Q_A**, **Q_B**, **Q_C**, **Q_D**, **Q_E**) kiritamiz. Bular qabul qilib oluvchi neyronlar qatlamini tashkil etadi. So‘ngra yashirin qatlam neyronlarida o‘rgatish va tekshirish amalga oshiriladi va natija bitta chiqish qatlamiga beriladi [4]. Oxirida har bir shinadagi kuchlanishlar **U_A**, **U_B**, **U_C**, **U_D**, **U_E** va kuchlanishlar og‘ishi **U_{phiu}**, **U_{phiu}**, **U_{phiu}**, **U_{phiu}**, **U_{phiu}** olinadi. Bu neyronlar ***chiquvchi neyronlar*** deb ataladi.

SNT da kiruvchi ma’lumotlar (yuklamalar) o‘zgaruvchan ma’lumotlardir. Elektr sxemasidagi EUL larining hamma parametrlar o‘zgarmas [5]. SNT 10ta kiruvchi neyronlar (**P_A**, **P_B**, **P_C**, **P_D**, **P_E** va **Q_A**, **Q_B**, **Q_C**, **Q_D**, **Q_E**), 17 ta yashirin neyron va 10 ta chiqish bor (**U_A**, **U_B**, **U_C**, **U_D**, **U_E** va **U_{phiu}**, **U_{phiu}**, **U_{phiu}**, **U_{phiu}**, **U_{phiu}**).

SNT asosidagi modelni hosil qilishda 50 ta kirish-chiqish statistic to’plamidan foydalanildi. Shulardan 70 % o‘qitish uchun, 30 % esa tekshirish uchun ishlatildi. O‘qitilish uchun Levenberg-Marquardt usulidan foidalanildi (5-rasm).



5-rasm. SNT da o‘qitilish jarayoni

SNT yordamida olingan natijalarni Nyuton – Rapson usulida olingan natijalar bilan solishtiramiz natijalari 4 – jadvalda keltirilgan.

4-jadval. Barqarorlashgan holatni xisoblash natijalarini solishtirish.

Shina 1	Nyuton - Rapson		Sun’iy Neyron Tarmoq		Farqi	
	Kuchlanish	Burchak	Kuchlanish	Burchak	Kuchlanish	Burchak
P_1,Q_1	6,133828	1,484291	6,134	1,484	0,002804043	0,01960532
P_1,Q_1	6,151551	1,667045	6,152	1,667	0,00729844	0,002699387
P_1,Q_1	6,173292	1,908016	6,162	1,908	0,183252191	0.000838574
P_1,Q_1	6,129817	1,337883	6,13	1,338	0,002985318	0,008745159
P_1,Q_1	6,079519	0,8800856	6,08	0,8802	0,007911184	0,012998736

Shina 2	Nyuton - Rapson		Sun’iy Neyron Tarmoq		Farqi	
	Kuchlanish	Burchak	Kuchlanish	Burchak	Kuchlanish	Burchak
P_2,Q_2	5,930085	-0,8926295	5,93	-0,8927	0,00143339	0,007898014
P_2,Q_2	5,951327	-0,6632786	5,951	-0,6631	0,005494875	0,026926845
P_2,Q_2	5,972878	-0,4125734	5,962	-0,4175	0,182455552	1,491602339
P_2,Q_2	5,961082	-0,5388077	5,961	-0,539	0,001375608	0,035689913
P_2,Q_2	5,879147	-1,478829	5,879	-1,479	0,002500425	0,011563203

Shina 3	Nyuton - Rapson		Sun’iy Neyron Tarmoq		Farqi	
	Kuchlanish	Burchak	Kuchlanish	Burchak	Kuchlanish	Burchak
P_3,Q_3	5,881859	-1,657673	5,882	-1,658	0,002397144	0,019726448
P_3,Q_3	5,909349	-1,286867	5,909	-1,287	0,005906245	0,010335178
P_3,Q_3	5,92486	-1,094695	5,917	-1,091	0,132837587	0.338680110
P_3,Q_3	5,92337	-1,091214	5,923	-1,091	0,006246834	0,019611185
P_3,Q_3	5,846624	-2,082702	5,847	-2,083	0,006430648	0,014308336

Shina 4	Nyuton - Rapson		Sun’iy Neyron Tarmoq		Farqi	
	Kuchlanish	Burchak	Kuchlanish	Burchak	Kuchlanish	Burchak
P_4,Q_4	6,018489	0,1138167	6,018	0,1139	0,008125623	0,073187854
P_4,Q_4	6,027073	0,2119523	6,027	0,2123	0,001211216	0,164046344
P_4,Q_4	6,040765	0,3736177	6,034	0,3733	0,112114683	0.085105813
P_4,Q_4	6,038003	0,3423419	6,038	0,3423	4,96853E-05	0,012239226
P_4,Q_4	5,986465	-0,2589536	5,986	-0,259	0,007768126	0,017918268

Shina 5	Nyuton - Rapson	Sun’iy Neyron Tarmoq	Farqi

	Kuchlanish	Burchak	Kuchlanish	Burchak	Kuchlanish	Burchak
P_5,Q_5	6,084519	0,621181	6,084	0,6208	0,008530572	0,06133478
P_5,Q_5	6,092985	0,7245269	6,093	0,7243	0,000246184	0,031316988
P_5,Q_5	6,105939	0,8920599	6,099	0,898	0,11377275	0.661481069
P_5,Q_5	6,10136	0,8485606	6,101	0,8481	0,005900672	0,054280154
P_5,Q_5	6,055647	0,2580654	6,056	0,2583	0,00582893	0,090907189

Xulosa

Elektr sistemasida quvvat oqimini tahlil qilishning asosiy muammosi qisqa vaqt ichida ko‘p parametrlarni tahlil qilish kerakligidir. Bu muammoni bartaraf etish uchun bir qancha zamonaviy elektr sistemasida quvvat oqimini tahlil qilish metodlardan biri sun’iy neyron tarmoqlardir.

Maqolada beshta shinali sistemada quvvat oqimining tahlili har tomonlama tahlil qilingan. Birinchi klassik usulda ya’ni Nyuton – Rapson metodida bajarilgan. Shundan so‘ng sun’iy neyron tarmoqda bajarilgan. Taqqoslash uchun yechimlar 4 – jadvalda berilgandan ko‘rinib turibdiki. Taklif etilayotgan metod yechimlari satatistikasi klassik metod yechimlariga yaqinlashish xatoligi chegaralarini qanoatlantiradi. Taqqoslashlardan ko‘rinib turibdiki elektr sistemaning quvvat oqimi muammolarini tahlil qilishda sun’iy neyron tarmoq metodidan foydalanish mumkin ekan.

Foydalanilgan adabiyotlar

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