On the optimality of one power system

Maksat Kalimoldayev[a], Muvasharkhan Jenaliyev[b], Assel Abdildayeva[c], Leila Kopbosyn[d]
[a,b,c,d] *The Institute of Information and Computational Technologies, Kazakhstan*
[a]mnk@ipic.kz, [b]muvasharkhan@gmail.com, [c]abass_81@mail.ru,
[d]Leila_s@list.ru

Abstract: We will consider a mathematical model that describes the transients in the electrical system, and represents the following system of nonlinear differential equations:

$$\frac{d\delta_i}{dt} = S_i,\ \ H_i\frac{dS_i}{dt} = -D_iS_i - E_i^2Y_{ij}\sin\alpha_{ij} - P_i\sin(\delta_i - \alpha_i)$$
$$-\sum_{j=1, j\neq i}^{\mathrm{l}} \mathrm{P_{ij}}\big(\delta_{ij} - \alpha_{ij}\big) + u_i,\quad i = \overline{1,l},\quad t \in [0,T] \qquad (1)$$
$$\delta_{ij} = \delta_i - \delta_j,\quad P = E_iUY_{i,n+1},\quad P_{ij} = E_iE_jY_{i,j},$$

where δ_i is angle of rotation of the rotor of i-th generator with respect to some synchronous rotational axis (the axis of rotation of constant voltage tires, it makes 50 rev / sec); S_i is sliding of the i-th generator; H_i is constant inertia of i-th machine; u_i is electromotive force i-th machine; Y_{ij} is mutual conductance of i-th and j-th system branches; U=const is the voltage on constant voltage tires; $Y_{i,n+1}$ is characterizes the contact (conductivity) of i-th oscillator with constant voltage tires; D_i=const≥0 is mechanical damping, $\alpha_{ij}\alpha_i, \alpha_j$ are constants, taking into account the influence of active resistances in the generator stator circuits. The complexity of model (1) consists in considering analysis α_{ij} with the following property $\alpha_{ij} = \alpha_{ji}$. We believe that the conditions $\delta_{ij} = -\delta_{ji}$ are realized. In this case, the model (1) is not conservative; so it isn't possible to build for it the Lyapunov function in the form of the first integral. This creates an additional difficulty for its research. System (1) is traditionally called the positional model, and it belongs to non-conservative class.

Keywords: electric power system, nonlinear system, phase system, control synthesis, Bellman-Krotov function.

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