Analysis Of Dynamic Stability Of Synchronous Generators In Hydro Power Station In The Electrical Energy System In The Matlab Software

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ABSTRACT

The article presents the equations of stability of the electric power system, the asynchronous mode and the asynchronous state of the system. A model of the differential equation in the Matlab program is constructed and the necessary results are obtained.

Keywords: static and dynamic stagnation, synchronous and asynchronous mode, Matlab, Simulink.

In the modern energy system, the main priority is to eliminate the problems of uninterrupted and high-quality supply of electricity to energy consumers. Today, in the energy system, the level of demand of consumers for electric power consumption increases rapidly, and as a result, the technical measures implemented in the energy system in the process of covering this demand may not be free of extraordinary defects, which may cause unexpected abnormal operating modes.

Abnormal regimes observed in the electric power system (short circuit, shutdown of power generating devices, emergency disconnection of parallel working or power supply lines) lead to disruption of the stability of the power system.

The stability of the electrical system is divided into several types. They are as follows: Static stability is the property of the system to return to its initial state or close to it by itself as a result of small impulses that occur in the system.

1) Dynamic stability is a property of the system returning to its initial or close to its original mode as a result of a series of impulses occurring in the system.
2) Resultant stability is a characteristic of the state of the electrical system, after the stability of the initial mode is disturbed, the synchronous operation is restored and the system is in an independent synchronous state [1].

Figure 1 shows the state of stagnation of the system. If the electrical system loses stability, asynchronous operation modes appear in the system. Asynchronous mode (AR) is a temporary mode in the power system, any part of which operates at a frequency significantly different from the synchronous mode. In other words, in AR, the force vector of the equivalent generator of a part of the power system out of synchronism EMF rotates with respect to the equivalent EMF vector of another part of the power system operating in synchronism [2].

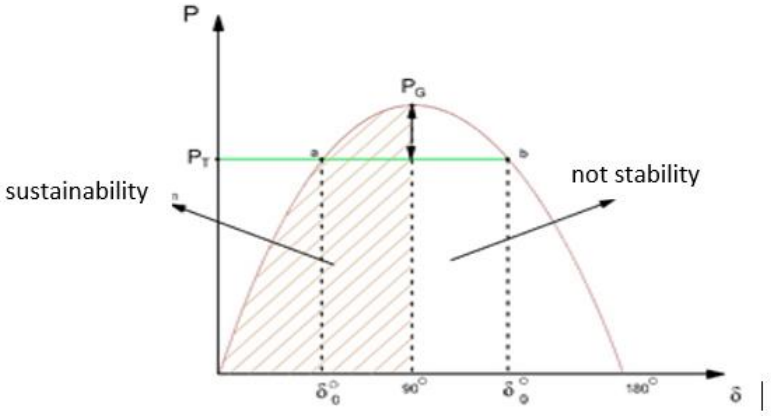


Figure-1 steady state graph of the system

In some cases, if the asynchronous operation of some parts of power systems refers to the asynchronous start-up of generators or synchronous compensators or self-monitoring of generators, the asynchronous transition mode (ah) is time-limited, but allowed refers to the abnormal operation mode of the energy system. If the operation of a synchronous machine (or a part of the power system) after AR is out of synchronization, then this is an emergency situation [3].

In Figure 3 below, we analyze the double-supplied parallel network power transmission system selected for analysis using the Matlab program:

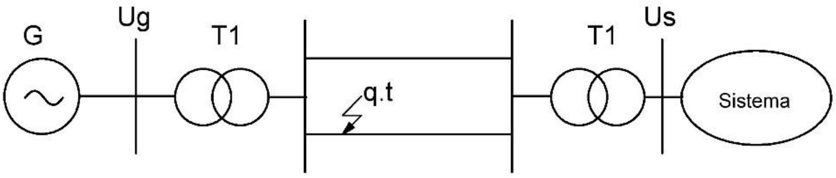


Figure-2

A simple circuit with double fuses

Figure-2 as can be seen from the diagram, a symmetrical short circuit is described in one of the air networks. As a result of a short circuit in one of the two parallel lines, the relay protection and automation devices installed on the buses of this line and the supply substations will turn off the network with a short circuit and the system will suddenly lose a large load. In this case, the rotor of the generator connected to the system starts to work in an accelerated manner. This, in turn, affects the stability of the system. The mathematical equation of the system for this case is as follows:

$$T_j \frac{d^2\delta}{dt^2} = P_T - P_{max} sin\delta \qquad (1)$$

Here P_T- steady-state power of the system, P_{max} − maximum power of the system. Formula (1) represents the normal state of the system. In this case, all the components that make up the system accept their nominal values and ensure the normal mode. So, we can model this equation in the Matlab program using the Simulink package. We use the operators available in the Simulink package to build the model. Below is a view of the constructed model.

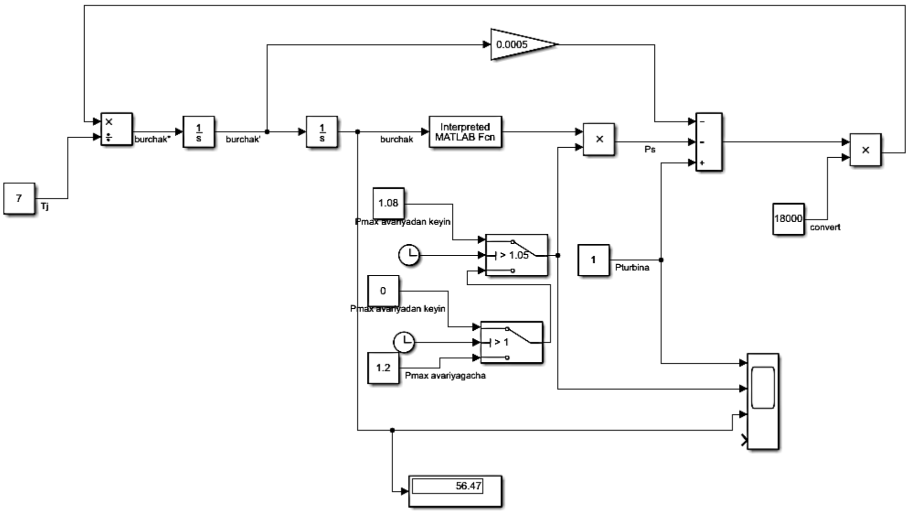


Figure-3 The model of the differential equation of the system in Matlab/Simulink

Using this model, the states of the system before the accident, during the accident and after the accident were analyzed using the equation given above. Figure 4 shows the switching scheme of the specified cases.

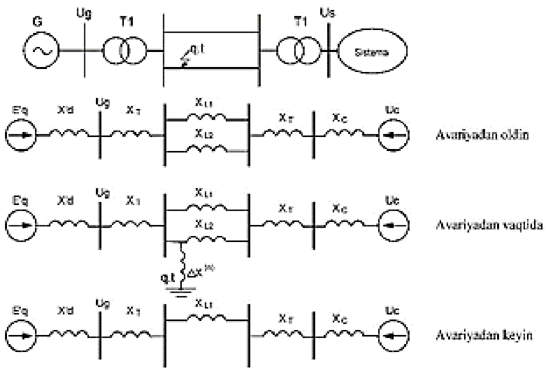
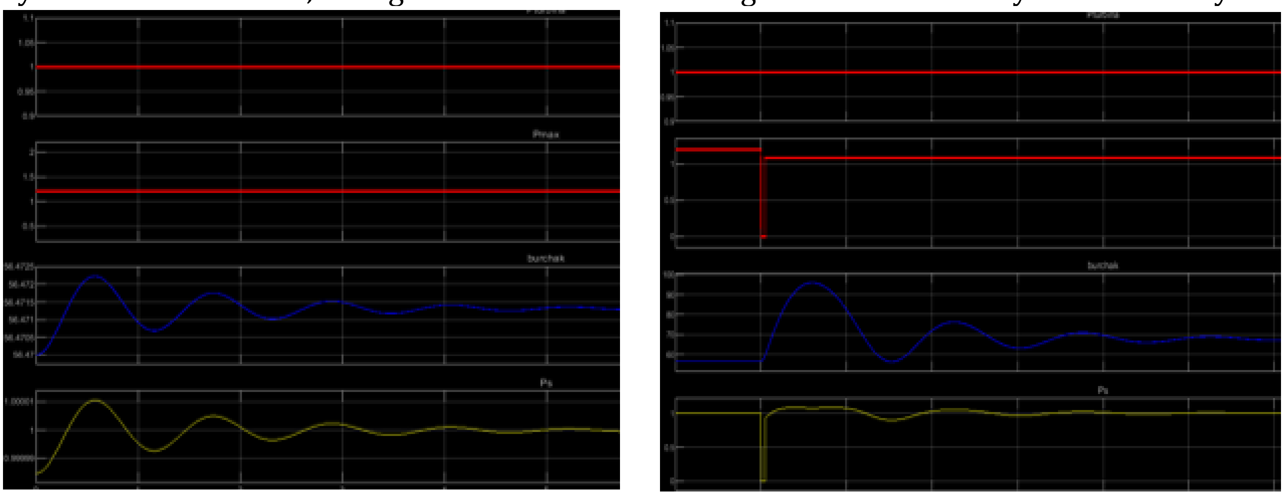


Figure-4 switching scheme of the tested network as a test

With the help of these switching schemes and using the capabilities of the Matlab program, the desired results are obtained. According to the obtained results, it can be seen in Figure 5a that the system has maintained its steady state. In this case, the generator first works in the deceleration mode and for a short time comes to its dynamic steady state. Figure 5b shows the keying graph during short circuit and short circuit time. During a short circuit, the automatic protection works and after 1 second, the generator reaches dynamic stability.



a) b)

Figure-5a pre-accident condition. figure-5b post-accident condition

Conclusion

Mathematical solutions of most problems in electrical energy have been worked out. It takes time and money to verify the practical suitability of these developed mathematical solutions. Above, we have analyzed various abnormal regimes observed in the energy system and the situations that may occur in these abnormal regimes using the Matlab program. The analysis shows that the mathematical model and the results obtained using the model in the Matlab program are the same.

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