Calculations of Power System Electromechanical Eigenvalues Based on Analysis of Instantaneous Power Waveforms at Different Disturbances

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Abstract

In the paper, there are presented the calculation results of eigenvalues associated with electromechanical phenomena (i.e. electromechanical eigenvalues) of the power system (PS) model state matrix based on the analysis of instantaneous power disturbance waveforms [1, 2, 3, 4]. The method used for calculations does not require determining the PS (linearized in the operating point) state matrix of large dimensions. The disturbances taken into account in the investigations are: pulse or step changes (by a few percent) in the voltage regulator reference voltage in one of generating units, a symmetrical short-circuit in a transmission line and a change in the value of the PS line equivalent impedance (due to, e.g., disconnecting or connecting a large power load). In the PS model, there was taken into account the impact of a central frequency regulator [3]. The presented method for calculations of eigenvalues consists in approximation of the instantaneous power waveforms by the superposition of modal components associated with the searched eigenvalues [2, 3]. This approximation can be performed by minimization of the objective function defined as a mean square error between the approximated and approximating waveform [2, 3]. The hybrid optimization algorithm [2, 3], being a serial combination of genetic and gradient algorithms, was used for minimization of the so-defined objective function. Such a combination allows eliminating the main disadvantages of both component algorithms. In order to avoid calculation errors caused by the algorithm freezing in an objective function local minimum, the calculations of eigenvalues were carried out repeatedly for each disturbance waveform. The calculation results with the objective function values larger than the assumed limit value were rejected. The arithmetic means from the non-rejected calculation results were assumed to be the final calculation results of the real and imaginary parts of particular eigenvalues [2, 3].

References

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