

This paper proposes a systematic approach to coordinately design probabilistically-robust wide-area power system stabilizers (WPSSs) for suppressing inter-area oscillations of power systems incorporating wind power. Specifically, the operating point of the system varies stochastically due to wind power integration and each operating point corresponds to a wind power generation scenario in the steady state. Thus, the WPSSs tuned by solving a delicately formulated optimization problem can maximize the occurrence probability of scenarios where the inter-area modes possess the acceptable damping ratios, and strictly constrain their unfavorable impacts. Multiple contingencies are also directly considered. In addition, several advanced techniques are tactfully employed for accurate and efficient evaluation of occurrence probability (objective function) during the optimization so as to ensure the proposed tuning method can deal with the highly nonlinear relationships between the system eigenvalues and the steady-state power outputs of wind farms; a customized differential evolution algorithm is proposed as well to efficiently solve the formulated optimization problem. Simulations and comparisons conducted on two classic test systems with proper modifications show the effectiveness and efficiency of the proposed control design method.