Abstract

Weakly interconnected multimachine power systems with AVRs introduce a negative damping in the system which are responsible for low frequency dynamic oscillations in 0.2-2.5 Hz range when subjected to even very small disturbances. These oscillations threatening the dynamic stability are taken care of by Power System Stabilizers (PSS) through supplementary control. Literature survey of research work published in this area has been compiled.

Most of the earlier works till date used pole assignment techniques considering only the dynamic modes for design of PSS parameters without taking into account the effect of other poles. So the closed loop system poles may render the system unstable in spite of the fact that the dynamic modes are perfectly damped. In order to overcome the problem, it is suggested in this thesis that, at first all the desired closed loop poles are selected to form a closed loop characteristic polynomial and a raw PSS in form of a biproper transfer function is evaluated. Then the order of the transfer function is reduced by the method of successive truncation keeping in mind the stability of all the closed loop poles after each step of truncation. Finally the transfer function is mapped into a standard lead-lag form to obtain the final structure of the power system stabilizer.

Next, a new coordinated dual signal approach of power system stabilization for multimachine power systems is proposed. Two signals are chosen and the phase lag of each of the signals with respect to the input of the system is found out separately at the desired oscillation frequency. Hence two decentralized stabilizer parameters corresponding to the two signals are calculated for the machine concerned. These decentralized stabilizer output signals are mixed in appropriate weights and fed to the input, ie., the summing junction of the terminal voltage reference of the automatic voltage regulator of the particular machine. Computation of the weightage elements is performed on the basis that parameterization of these elements reflects the corresponding parameterization of the dynamic mode eigenvalues. This technique invokes a tensor multiplication subroutine for converting the eigenvalue-eigenvector equation to a standard matrix differential equation form. This parameterization approach has been tested for speed-electric power dual signal coordinated PSS and local-global speed coordinated PSS with both cases the signals being of analog and discrete form. Thus the inherent tendency of a system with only speed stabilizer installed to undergo torsional oscillations are minimised if not eliminated through the proposed $(\Delta\omega, \Delta P_e)$ coordinated PSS system. Local and global signals used may be suitable for damping out both local and inter-area modes.

Reliability related robustness test has been performed first by considering many of the PSS signals put off. Next, parametric robustness has been analysed by simulating the machine through various operating conditions and then by Kharitonov's robustness criteria of polynomials. Thus the entire regime of change in operating conditions that can be tolerated by the simple scheme without resorting to complicated adaptive control method with prohibitive cost is also established and defined.

An artificial neural network approach to coordinated design of PSS has been formulated where the input to the network mainly comprises of speed and electric power deviation signals. A multi-layer feedforward network with back-propagation training algorithm is chosen for study. The network has been trained over a wide range of operating conditions in order to make the neural net PSS work properly in wide range of system operating conditions. The ANN is then introduced in the feedback loop of the plant and its performance compared with existing power system stabilizers. It is evident, from the simulation tests, that the ANN PSS is able to provide significant damping to the sample single machine system.

A comprehensive list of published papers of various research groups related directly or indirectly to PSS and some of the documented and accepted single and multimachine modelling formulation is provided at the end for ready reference.