Abstract

Small signal oscillation has been always a major concern in the operation of power systems. In a generator, the electromechanical coupling between the rotor and the rest of the system causes it to behave in a manner similar to a spring mass damper system, which exhibits an oscillatory behaviour around the equilibrium state, following any disturbance, such as sudden change in loads, fluctuations in the output of turbine and faults etc. The use of fast acting high gain AVRs and evolution of large interconnected power systems with transfer of bulk power across weak transmission links have further aggravated the problem of these low frequency oscillations. Small oscillations in the range of about 0.1Hz to 3.5Hz can persist for long periods, limiting the power transfer capability of the transmission lines. Power System Stabilizers (PSS’s) were developed as auxiliary controllers on the generators excitation system to produce additional damping by modulating the generator excitation voltage. Designing effective PSS for all operating conditions specially in large interconnected power systems still remains a difficult and challenging task.

The conventionally designed Power System Stabilizer (CPSS) is the most cost-effective electromechanical damping controller till date. However, continual changes in the operating condition and network parameters in large systems result in corresponding large changes in system dynamics. This constantly changing nature of power system makes the design of CPSS a difficult task. The design and tuning of PSS for robust operation is a laborious process. The existing PSS design techniques require considerable expertise, the complete system information and extensive eigenvalue calculations which increases the computational burden as the system size increases.

This thesis proposes a method for designing robust power system damping controllers that ensures a minimum robustness under model uncertainties. The minimum performance required for the PSS is set a priori and accomplished over a range of operating
A generalized robust controller design methodology has been first implemented on a Single Machine Infinite Bus (SMIB) power system model. The robust controller places the closed loop rotor modes of the system to the desire location while keeping the electrical modes intact. Unlike conventional lead/lag PSS design, the proposed PSS design is based on pole assignment technique which takes into account of various model uncertainties.

For the proposed stabilizer design in a multi-machine systems a new decentralized method has been used which requires system data only up to secondary bus of the unit transformer in a generating station. The proposed robust controller design based on modified Nevanlinna-Pick theory has been designed and tested extensively on SMIB and multi-machine systems to establish the efficacy of the controller in damping small signal oscillations.

The thesis is organized in four chapters as follows.

The first chapter discusses the basic concepts related to the rotor angle stability in power systems. The conventional and other methods of countering this instability by power system stabilizers have been described. The relative merits of the various stabilization techniques have been discussed. The scope of present work, i.e. design of decentralized robust power system controllers has been defined.

In second chapter a modified robust power system stabilizer for SMIB system is developed. It has been shown that under specific conditions the modified Nevanlinna-Pick theory can also be applied for designing damping controllers in system with lightly damped rotor modes.

Third chapter proposes a decentralized approach based on modified Nevanlinna-Pick theory for designing a power system stabilizer for interconnected power systems. The performance of the controller which is not based on external system information has been investigated on three widely used multi-machine test systems to establish its efficacy in damping out low frequency oscillations.

The fourth chapter gives a brief summary of the work done and also includes a section on the scope of future work relating to design of power system stabilizers.