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Original article

# Design of robust electric power system stabilizers using Kharitonov's theorem

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**Abstract**

A robust power system stabilizer (PSS) is proposed as an effective way to damp-out oscillations in electric power systems. Oscillations of small magnitude and low frequency, linked with the electromechanical models in power systems, often persist for long periods of time and in some cases present limitations on the power transfer capability. The proposed PSS is designed according to Kharitonov's extremal gain margin theory. It has the following advantages: (i) it is based on simultaneous stabilization of limited number of extreme plants, (ii) the control design can be based on frequency response analysis techniques (root locus diagrams or Nyquist plots) and (iii) the resulting controller is a low-order phase-lead compensator, which is robust to the change of operating points. The proposed power system stabilizer is tested through simulation experiments.


*Keywords:* Electric power system stabilization; Oscillation damping; Kharitonov's theory; Frequency response analysis

## 1. Introduction

Modern large-scale power systems have commonly experienced adverse impacts on the their operation and cascading events due to under-damped oscillations [8,9,15]. The objective of this research work is to develop robust power system stabilizers that will be able to suppress the oscillatory behavior of the power systems over a wide range of operating conditions, thus assuring their secure operation. The paper proposes a robust power system stabilizer (PSS) as an effective way to damp-out oscillations in electric power systems. Since power generation systems are actually nonlinear, conventional fixed parameter PSS cannot cope with great changes in operating conditions.

Due to frequent variations in the power system's operating conditions it is difficult to obtain a precise model of its dynamics and consequently to design a power system stabilizer [14]. The most common causes of uncertainty about power system dynamics are the following: (i) changes in power consumption, (ii) changes in operating states resulting from changes in the generation and transmission device structure, (iii) variation of operating conditions of the generators and (iv) changes in the network configuration and the number of operating generation units.

In the context of the above mentioned parametric uncertainties, the problem of designing a power system stabilizer using a nonlinear dynamical model is a non-trivial one. A first approach would be to linearize the system's model using

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