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NOISE-INDUCED FRACTAL BOUNDARY OF SAFE BASIN IN THE SOFTENING DUFFING OSCILLATOR

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Abstract. Many dynamical systems are common in which two or more attractors coexist and in such cases the basin boundary is incursively fractal. The present paper studies the effect of stochastic noise on erosion of safe basin in the softening Duffing oscillator. By employing the Monte-Carlo method, the safe basins are simulated for the deterministic and the stochastic cases of the system, and the ratio of safe initial points (RSIP) in given limited domain defined by the system's Hamiltonian is presented for various excitation strength and first-passage time. It is shown that the erosion of the safe basin can be aggravated by both the Gaussian white and the bounded noise excitations, and fractal boundary can still appear when the system is excited only by the stochastic noises.
Moreover, results from the RSIP in given limited domain show that, sudden jumps and intersections between the RSIP curves can occur when harmonic excitation is imposed on the oscillator, but the jumps may be shortened and smoothed and no any intersection can arise if the oscillator is excited only by the Gaussian white or the bounded noise.
Keywords. Softening Duffing oscillator, stochastic excitation, safe basin, erosion, fractal boundary.
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1 Introduction

Engineering structures are often subjected to time dependent loadings of both deterministic and stochastic nature, such as those occurring due to wind gusts, earthquakes, and ocean waves. Therefore, in the study of dynamics of engineering structures, the existence of noise as an external perturbation cannot be ruled out. The problem of the response of nonlinear oscillations to stochastic excitation has been studied extensively. Interest in this scientific area has been generated by problems encountered in various technical fields such as aeronautical, control, earthquake, ocean and transportation engineering, etc.

When an oscillator with potential well is subjected to stochastic excitation, it is usually necessary to estimate the probability that the systems will