Nonlinear Dynamics and Systems Theory, **19** (4) (2019) 464–473

Uniform Asymptotic Stability in Probability of Nontrivial Solution of Nonlinear Stochastic Systems

A. Barbata [1*], M. Zasadzinski [2*], R. Chatbouri [3] and H. Souley Ali [2]

[1] *UR Analysis and Control of PDEs, University of Monastir, Tunisia;*
[2] *Research Center for Automatic Control (CRAN, UMR 7039, CNRS), University of Lorraine, 186 rue de Lorraine, 54400 Cosnes et Romain, France;*
[3] *Laboratory of Mathematics, Physics and Special Functions, University of Sousse, Tunisia*

Received: July 1, 2019; Revised: September 16, 2019

Abstract: The aim of this paper is to study the uniform asymptotic stability in probability when a nonlinear stochastic differential equation does not have a trivial solution. For nontrivial solutions of a nonlinear stochastic differential equation, the problem of uniform asymptotic stability in probability is reformulated for a ball of radius $R > 0$. Based on this new formulation, a theorem for the uniform asymptotic stability in probability for this ball is proposed by using a Lyapunov approach.

Keywords: *stochastic systems; Itô formula; Brownian motions; stability in probability; asymptotic stability in probability.*

Mathematics Subject Classification (2010): 93E03, 93E15.

1 Introduction

In this paper, we discuss a new concept of uniform asymptotic stability in probability for stochastic systems which are described by stochastic differential equations (SDEs) driven by multiplicative noises. These systems differ from ordinary differential equations (ODEs) modeling deterministic processes. Unlike an ODE, a SDE contains two terms: the drift for the evolution of time and the diffusion for the action of the Brownian motion. These systems correspond to Itô processes, and the noises that affect them are Brownian motions, also called the Wiener processes. This kind of equations is extensively studied in [8, 16, 17] and references therein.

Numerous phenomena are described by this class of models when a deterministic description is not satisfactory: in finance (financial mathematics and stock prices), biology

* Corresponding author: mailto:barbata_asma@yahoo.fr