**Notification No.: 508/2022**

**Date of Award: 28-02-2022**

**Name: HARINDRI CHAUDHARY**

**Name of the Supervisor: Prof. Ayub Khan**

**Department: Mathematics, Jamia Millia Islamia, New Delhi-110025, India**

**Title of the Thesis: Co-existence of Non-Linear Dynamical Systems and Chaos Theory**

**Abstract**

More than three decades of extensive studies in nonlinear dynamics has raised the query on the real-life applications of chaos phenomena. One of the reasonable answers to this problem is the controlling chaotic behaviour to make it predictable. The recent concept of chaos synchronization using different chaos controlling techniques has been studied in the present thesis which is an appealing one.

The thesis has been divided into six chapters. A brief summary of the research work carried out in this thesis is as:

**Chapter-1 (Introduction),** This chapter is introductory that deals with a brief survey of some historical aspects, essential notations and terminology and some supporting results related to chaos control methods and chaos synchronization schemes among chaotic systems to be used in the subsequent chapters of the thesis. It also contains the recent developments related chaos synchronization during the three decades.

**Chapter-2 (Adaptive Hybrid Projective Synchronization of Hyperchaotic Systems),** In this chapter, we design a procedure to investigate the hybrid projective synchronization (HPS) technique among two identical hyperchaotic systems. An adaptive control method (ACM) is proposed which is based on Lyapunov stability theory (LST). This technique globally determines the asymptotical stability and establishes the effect of parameter simultaneously via HPS approach. Numerical simulations are carried out for visualizing the effectiveness and feasibility of discussed synchronization scheme by using MATLAB.

**Chapter-3 (Hybrid Projective Combination-Combination Synchronization in Non Identical Hyperchaotic Systems using Adaptive Control),** In this chapter, we investigate a hybrid projective combination-combination synchronization (HPCCS) scheme among four non-identical

hyperchaotic (HC) systems via adaptive control method (ACM). Based on Lyapunov stability theory (LST), the considered approach identifies the unknown parameters and determines the asymptotic stability globally. The proposed scheme is applicable in secure communication and information processing. Finally, numerical simulations are performed to demonstrate the effectivity and accuracy of the considered synchronization as well as control techniques by using MATLAB.

**Chapter-4 (Hybrid Projective Synchronization in Identical Hyperchaotic Systems using Active Control),** In this chapter, a systematic procedure for investigating hybrid projective synchronization (HPS) scheme in two identical hyperchaotic systems has been designed. Based on Lyapunov stability theory (LST), an active control technique (ACT) has been presented to achieve the desired HPS scheme. Moreover, computer simulations are implemented to validate the efficacy and feasibility of the considered approach by using MATLAB. Remarkably, the analytic and computational results are in complete agreement. The considered HPS scheme is very efficient as it has numerous applications in image encryption and secure communication.

**Chapter-5 (Stability Analysis of Chaotic Generalized Lotka-Volterra System via Active Compound Difference Anti-Synchronization Method),** In this chapter, a systematic approach is proposed to investigate compound difference anti-synchronization (CDAS) among four identical chaotic generalized Lotka-Volterra biological systems (GLVBSs). Initially, a nonlinear active control method (ACM) is proposed which is primarily based on the Lyapunov stability theory (LST). Biological nonlinear control law is designed to achieve the asymptotic stability criterion of the error dynamics of the considered system. Numerical simulations using MATLAB software are presented to illustrate the effectiveness and superiority of the considered scheme. Exceptionally, the achieved analytical results are in complete agreement with computational results.

**Chapter-6 (A Synchronization Approach to the Stability Analysis of Microscopic Chaos Generated in Chemical Reactor System),** This chapter investigates the synchronization accomplishments of two broadly used chaos synchronization strategies: active control and adaptive control. It is demonstrated that the considered techniques have efficient performances in the synchronization of microscopic chaos generated in chemical reactor system (CRS) with the adaptive control method slightly outperforming the active control design in terms of transitory analysis. Nevertheless, the complexity of nonlinear adaptive control functions indicates that the active control would be more achievable in several engineering applications.