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Asit Saha · Santo Banerjee
Editors

Proceedings of the 2nd
International Conference
on Nonlinear Dynamics
and Applications (ICNDA
2024), Volume 3

Dynamical Models, Communications and
Networks

Editors

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Preface

Systems controlled by complicated equations, as opposed to simple linear ones, are the focus of nonlinear dynamics, a branch of mathematics and physical science. Oftentimes, these systems display chaotic behavior, in which even little modifications to the starting circumstances may result in wildly diverse final products. Nonlinear dynamics is used to study phenomena such as water waves, fluid flow, waves in space, solar wind, turbulence, instability, nuclear fusion, signal transmission, weather patterns, population growth, and the behavior of financial markets. By understanding the underlying principles of nonlinear systems, scientists and mathematicians can make predictions and gain insights into the behavior of these complex systems. In these systems, the principle of superposition does not hold, meaning that the behavior of the system is not directly proportional to the input. Instead, small changes in the input can lead to disproportionate changes in the output, making these systems difficult to predict and control. By utilizing mathematical tools such as chaos theory and bifurcation analysis, researchers can uncover the hidden patterns and structures within these systems, ultimately leading to a deeper understanding of the world around us. A fascinating topic with applications in many domains, nonlinear systems may display a wide range of behaviors, including stable equilibria, periodic oscillations, and chaotic dynamics.

This proceeding encompasses these topics through the contribution of three volumes, which include a total of 157 research articles:

Volume 1: *Nonlinear Waves and Plasma Dynamics*

Volume 2: *Complex Systems, Fractals and Nonlinear Flows*

Volume 3: *Dynamical Models, Communications and Networks.*

Volume 1: Within the first volume, there are fifty-five publications that are devoted to the investigation of nonlinear wave and plasma dynamics. Nonlinear waves and plasma dynamics is a fascinating field that explores the behavior of waves and plasmas when governed by nonlinear equations. In the context of wave dynamics, nonlinearity can result in phenomena such as solitons—stable, localized wave packets that maintain their shape while traveling at constant speeds. These occur in various media, from water waves to optical fibers. Plasma dynamics, which studies ionized gases consisting of charged particles, also displays rich nonlinear behavior. In plasmas, nonlinear interactions can lead to complex structures like filaments and turbulence. Understanding these dynamics is crucial for applications ranging from controlled nuclear fusion to space weather prediction.

Volume 2: From basic mechanical oscillators to intricate biological networks and turbulent fluid fluxes, dynamical systems cover it all. Chaos, Complexity, and Fractals and Fluid Dynamics and Nonlinear Flow are two major subfields of dynamical systems. In Chaos, Complexity & Fractals, we explore the complex dynamics that may arise from nonlinear systems that are sensitive to their starting circumstances. By delving into chaotic systems, chaos theory reveals intriguing patterns and structures that lie

beyond the surface of apparently random activity. Complexity theory, in contrast, seeks to explain phenomena like self-organization and emergence by analyzing the emerging characteristics of complex systems with many interacting components. From the complex curves of coastlines to the branching architectures of trees, fractal geometry provides a mathematical foundation for understanding the self-similar patterns seen in nature. The field of fluid dynamics and nonlinear flow studies how fluids behave in different flow regimes, from smooth to choppy. Turbulence, vortex, and instability are all products of nonlinear processes, which are fundamental to fluid dynamics. Predicting and managing fluid flow in applications ranging from climate modeling to aeronautical engineering requires an understanding of these nonlinear interactions. Investigating the behavior of nonlinear systems allows scientists to find previously unknown relationships, principles, and patterns, which in turn leads to game-changing findings in many fields. This volume contains forty-seven research articles.

Volume 3: Within the larger framework of nonlinear dynamics, the intriguing domains of graphs, networks, and communications stand out. The application of nonlinear dynamics concepts to the study of complex network behavior has recently attracted a lot of attention. These networks may be anything from social networks to biological systems. A robust framework for studying the dynamics and structure of linked systems is given by graph theory. How these networks change across time, displaying behaviors like self-organization, cascading failures, and synchronization, may be better understood by looking at nonlinear dynamics. Applications such as information distribution, epidemic modeling, and infrastructure resilience rely on a thorough understanding of the dynamics of complex networks. The lessons learned from nonlinear dynamics are applicable to communications systems as well. Signal amplification, distortion, and interference are nonlinear phenomena that impact the complex interactions that occur during signal transmission across communication networks. Scientists may improve communication protocols, create more reliable networks, and lessen the impact of signal deterioration by using principles from nonlinear dynamics. In addition to wave dynamics, plasma physics, communications, graphs, and networks, nonlinear dynamics has many more potential uses. Among these fields are climatology, neurology, ecology, and economics. The influence of nonlinear events on system behavior is crucial in all of these areas, often resulting in unforeseen consequences and the emergence of new characteristics. All things considered, there is a vast array of phenomena to investigate in the study of nonlinear dynamics in many domains, which has ramifications for both theoretical and applied knowledge. Researchers are finding fresh insights and novel solutions to real-world problems by exploring the nonlinear elements of complex systems further.

The editors of this proceedings express their heartfelt gratitude to all participants, invited speakers, keynote speakers, paper presenters, and members of the scientific advisory and technical program committees for their enthusiastic involvement in the 2nd International Conference on Nonlinear Dynamics and Applications - 2024 (ICNDA 2024), organized by the Department of Mathematics, Sikkim Manipal Institute of Technology, Sikkim Manipal University, held from February 21 to 23, 2024, in Sikkim, India. We extend our sincere appreciation to the Science and Engineering Research Board (SERB), Council of Scientific & Industrial Research (CSIR), & SMIT, for their

sponsorship of this event. Additionally, we are grateful to the authorities, faculty members, staff, volunteers, and organizing committee members of SMIT for their invaluable support and assistance in making this conference a grand success.

The editors of this proceedings extend their gratitude to the authors for their valuable contributions and to the referees for their diligent efforts in reviewing the articles. We trust that the selected papers in this proceedings will enhance readers' understanding and will be beneficial to scientists and researchers in advancing the theory of nonlinear waves, chaos, complexity, dynamical systems, and their applications. We would like to convey our heartfelt appreciation to all members of Springer Proceedings in Physics for hosting this proceedings.

Asit Saha
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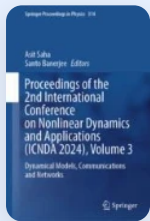
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High Cycle Fatigue Behavior of TIG Welded Joint at Optimum Parametric Condition

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Abstract

In this study, AISI 316L stainless steel plates are joined together in a square butt joint arrangement using a semiautomatic tungsten inert gas (TIG) welding process. The

research project has two goals in mind. To create mathematical models based on the recorded data, a series of experiments are first carried out using the Box-Behnken design of response surface methodology (RSM). Next, desirability function analysis (DFA) is used to perform multi-objective optimisation for a subset of responses at once. Secondly, a set of another TIG welded joints are prepared at the obtained optimum parametric condition and then high cycle fatigue behaviour of the welded joints as well as base metals are investigated at room temperature with a stress ratio $R = 0.1$. Furthermore, the fracture surfaces of the fatigued specimens are analysed by scanning electron microscopy (SEM). The result shows that welded joint depicts almost 8% higher fatigue limit compare to base metal.

S. C. Moi—Presenting author.

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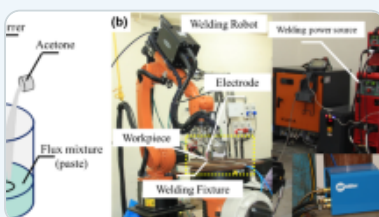
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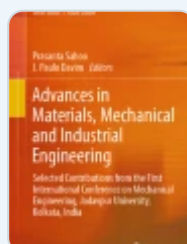
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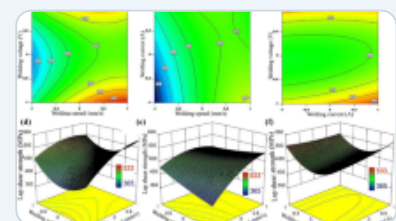
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