ICAMΣ'21

International Conference on Applied Mathematics in Engineering

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Book of Abstracts

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Preface

We would like to welcome all participants to join "The Second International Conference on Applied Mathematics in Engineering (ICAME'21)", which will be held September 1 to September 3, 2021 in Burhaniye/Balikesir, Turkey.

This conference allows an ideal academic platform for researchers to present the latest research and evolving findings of applied mathematics on engineering, physics, chemistry, biology, and statistics.

The conference also provides the opportunity of discussing advances in the field of applied mathematics, its effect on engineering and real-life problems. Especially, the conference discusses the most current applied mathematical problems in the world. For example, fractional calculus and its real-life applications, operational research, mathematical modeling in health science and engineering, optimization and control in engineering, non-linear dynamical systems and chaos, optimization and control problems are main topics of the conference.

In this conference, 143 oral presentations will be given to an audience with over 120 participants from 27 countries.

ICAME'21 is an achievement of international cooperation we continuously endeavor to carry out and develop. In this context, on behalf of the chairs of this conference, we would particularly like to thank: plenary speakers Albert C. J. Luo (Southern Illinois University Edwardsville, USA), Sverre Holm (University of Oslo, Norway), Gerhard-Wilhelm Weber (Poznan University of Technology, Poland) and Praveen Agarwal (Anand International College of Engineering, Jaipur, India) invited speakers Carla Pinto (School of Engineering, Polytechnic of Porto, Portugal), Huseyin Merdan (TOBB University of Economy and Technology, Turkey) and Amin Jajarmi (Department of Electrical Engineering, University of Bojnord, Iran) as well as the organizers of special sessions, and the members of the international scientific committee for their contributions and supports.

We would like to extend our best wishes to all of you with a hope that you go back with actual and more powerful ideas, and with new science networks renewed or extended.

Best wishes for an enjoyable and memorable conference.

On behalf of the organization committee,

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Plenary Speakers

Albert C. J. Luo

Southern Illinois University Edwardsville, USA

Infinite Unstable Periodic Orbits to Infinite Homoclinic Orbits in the Lorenz System

In nonlinear dynamics, homoclinic orbits are very essential for a better understanding of the corresponding global dynamics. However, it is very difficult to determine homoclinic orbits in 3-D or higher-dimensional nonlinear dynamical systems. In this talk, the routes from unstable periodic orbits to infinite homoclinic orbits are presented in the Lorenz system, and such homoclinic orbits are pertaining to unstable periodic orbits on bifurcation trees. Thus, a semi-analytical method is presented for determining unstable periodic orbits. This is because traditional computational methods cannot obtain unstable periodic orbits in nonlinear dynamical systems due to computational errors and perturbations. For demonstration, a period-doubling bifurcations tree of the period-1, period-2 and period-4 motions are presented. Periodic orbits and homoclinic orbits in the Lorenz system are illustrated through 3-D views, from which one can imagine complex stable and unstable periodic motions and the Lorenz attractors. Further, the corresponding mathematical structures of homoclinic orbits and Lorenz attractors can be further developed.

J. A. Tenreiro Machado

Institute of Engineering, Polytechnic of Porto, Portugal

The Logical Song

Data analytics is penetrating in all areas of the human activity. The availability of data measuring the behavior of complex phenomena allows a new quantitative perspective not conceivable with classical mathematical tools. This presentation addresses 3 distinct areas of key impact in society and that reflect the behavior of men kind. We consider music, artistic painting and soccer as manifestations of the human spirit that can be processed and analyzed, since large volumes of data are presently available in digital form. The data records are studied using several mathematical and computational tools, such as, fractional calculus, entropy, multidimensional scaling, hierarchical clustering and scientific visualization. The embedding of mathematical, computational and algorithmic modeling leads to the emergence of patterns that are analyzed and interpreted.

Sverre Holm

University of Oslo, Norway

Fractional Wave Equations and Complex Acoustic Media

Wave equations with non-integer derivative operators can describe attenuation which increases with frequency with other powers than two, unlike ordinary wave equations. Such attenuation is found in many complex media. Both shear and compressional waves in media as diverse as biological tissue, rocks, and sub bottom sediments are examples of this. These wave modes are central in applications such as medical ultrasound, diagnostic shear wave imaging in elastography, seismics, and underwater acoustics. These equations can be divided into two classes depending on whether they can be derived from more fundamental principles or not. In the first class one can find the fractional Kelvin-Voigt and fractional Zener wave equations, while several fractional Laplacian wave equations are in the second category. Such examples as well as the properties of their solutions will be presented. In many cases just having such a wave equation is enough to model a phenomenon.

In [Holm, S. (2019). Waves with power-law attenuation. Springer and ASA (Acoustical Society of America) Press] I also wanted to understand what it is about complex media that gives rise to power law behavior. The main attenuation mechanisms of standard acoustics are heat conduction and relaxation, structural relaxation, and chemical relaxation. They have fractional parallels and the first one is heat relaxation described by fractional Newton cooling due to anomalous diffusion. The most important mechanism is however the second one, the fractional parallel to structural relaxation. Instead of one there are multiple relaxation processes with a distribution of relaxation times that follows a power-law distribution, possibly indicating that the material has fractal properties. This distribution also has a relationship to the Arrhenius equation, indicating a link to chemical relaxation, albeit a quite speculative one.

Other sources of power-law behavior can be non-Newtonian rheology with time-varying viscosity and propagation when there is a fractal distribution of scatterers in an otherwise lossless medium. Existing models in sediment acoustics such as the grain shearing model and the Biot poroelastic model can also be reformulated with fractional operators. These approaches are presented in the hope of coming one step closer to answering if fractional wave equations give clues to some deeper reality, or if they are just a compact phenomenological description.

Dumitru Baleanu

Cankaya University, Turkey

On Singular and Non-Singular Fractional Operators and Their Applications in Mathematical Biology

The fractional calculus and its applications is a hot topic for researchers from many branches of science and engineering. Real world applications started to be investigated with a great sucees within this very helpful mathematical tool. In my talk I will concentrate on the sucessful applications of both singular and non-singular fractional operators to the complex dynamics of some mathematical biology systems. Besides, some new aspects of the classifcation of fractional operators will be presented. Illustratives examples will be provided.

Gerhard-Wilhelm Weber

Poznan University of Technology, Poland

Defined Contribution Pension Funds by Robust Stochastic Optimal Control

In the present work, we study the problem of optimal management of defined contribution pension funds, during the distribution phase, under the effect of inflation, mortality, and model uncertainty. More precisely, we consider a class of employees, who, at the time of retirement, enter a life assurance contract with the same insurance firm. The fund manager of the firm collects the entry fees to a portfolio savings account and this wealth is to be invested optimally in a Black-Scholes type financial market. As such schemes usually last for many years, we extend our framework, by: (i) augmenting the financial market with an inflation-adjusted bond, and (ii) taking into account mortality of the fund members. Model uncertainty aspects are introduced as the fund manager does not fully trust the model he/she faces. By resorting to robust control and dynamic programming techniques, we provide: (a) closed-form solutions for the case of the exponential utility function, (b) a detailed numerical study of the qualitative features of the problem at hand that elucidates the effect of robustness and inflation on the optimal investment decisions.

Praveen Agarwal

Anand International College of Engineering, Jaipur, India

Certain Generalization of Fractional Derivative Operators

Many authors have introduced and investigated certain extended fractional derivative operators. The main object of this talk to study extended fractional differential operators(such as the Riemann-Liouville and Caputo type fractional operators) involving generalized hypergeometric functions introduced recently and investigate its various (potentially) useful and (presumably) new properties and formulas, for example, integral representations, Mellin transforms, generating functions, and the extended fractional derivative formulas for some familiar functions.

Invited Speakers

Jordan Hristov

University of Chemical Technology and Metallurgy, Bulgaria

Fractional Operators with Non-Singular Memories in Viscoelasticity: Basic Concepts Applicable to Linear and Non-Linear Viscoelasticity

The fractional operators with non-singular memory kernel described by exponential (Caputo-Fabrizio derivative) and generalized Mittag-Leffler function (Atangana-Baleanu derivative) raise many questions about their properties and mainly about their physical relevance and applications.

This lecture focuses on basic principles in description relaxation behaviors of linear and non-linear viscoelastic materials and the adequate selection of the memory kernels of the fractional operators leading to both derivatives with singular or non-singular memories.

The targets are non-aging (linear and non-linear) viscoelastic materials with behaviors beyond the power-law limit related to the Caputo fractional derivative. The stress-strain response functions are the main physical objects allowing selecting the corresponding memories of the fractional operator sand their constructions. As a consequence of the memory kernel selection, the causality of both the constitutive equations and the frequently used rheological equations are discussed.

Carla Pinto

School of Engineering, Polytechnic of Porto, Portugal

Tackling specificities of different diseases using within-host models

Epidemics make exciting news. They are often presented with dramatic headlines, and the pictures accompanying them are of healthcare workers dressed with protective equipment or working at labs. People often forget about the behind scenes work of mathematicians, who, with more or less simplified models, help on the understanding and prediction of infections spread. In this lecture I will focus on several within-host models useful for a deeper knowledge of virus dynamics with different specificities, namely HIV, HCV, HSV-2, etc.

Huseyin Merdan

TOBB University of Economy and Technology, Turkey

Nonlinear dynamics of a ratio-dependent prey-predator model: Stability, bifurcations and chaos

Nonlinear dynamical behaviors of a prey-predator system with Leslie type will be presented. First, the dynamics of its continuous form will be analyzed; the local and global stabilities and bifurcations will be discussed. Second, the dynamical behavior of its discrete form will be analyzed; bifurcations and chaotic behavior will be shown. Numerical simulations will be given to support and extend the theoretical results. Finally, we will compare the results that we obtained.

Amin Jajarmi

Department of Electrical Engineering, University of Bojnord, Iran

Recent developments in the mathematical modelling and control of biological system

Recently, the new aspects of fractional calculus have been widely employed to investigate different features of many complex biological systems. In this direction, fractional models help us to understand how the memory of the certain components of a system affects the progress of diseases as a whole, and therefore, it enables us to implement the memory effects into the evolution of considered system together with its environment. This kind of analysis is also important in order to improve the current medications and to explore new ways of quick, effective and low-cost treatments. In this talk, we explore a recent development in the mathematical modelling of biological systems. The complex dynamics of an epidemic are investigated within the use of both classical and a new fractional framework. The obtained results are analyzed by the help of some simulations in a comparative way for both integer- and fractional-order cases. Finally, an efficient control scheme is designed for the purpose of intervention in an appropriate, effective way.

Special Sessions

Modelling & Optimization in Engineering

Ramazan Yaman, Istanbul Atlas University, Turkey
Ahmet Sahiner, Suleyman Demirel University, Turkey
Fırat Evirgen, Balikesir University, Turkey

Theme

The goal of this session is to discuss recent developments in applications of optimization methods by bringing together researchers and practitioners working in the field of optimization theory, methods, software and related areas.

Topics

Mathematical programming
Global optimization
Nondifferential optimization
Continuous optimization
Combinatorial optimization
Multicriteria optimization
Equilibrium programming
Game theory
Data mining
Population based algorithms
Artificial intelligence technologies
Applications of optimization in natural sciences
Applications of optimization in engineering
Energy systems modelling and optimization

Operational Research

Gerhard-Wilhelm Weber, Poznan University of Technology, Poland
Aslan Deniz Karaoglan, Balikesir University, Turkey
Ibrahim Kucukkoc, Balikesir University, Turkey
Burcu Gurbuz, Uskudar University, Turkey

Theme

This session aims to bring together researchers working on the topics related to operational research to discuss recent developments in the theory and application of operational research techniques.

Topics

Business analytics for manufacturing systems
Analytics, optimization and machine learning in manufacturing and supply chains
Intelligent manufacturing systems
Intelligent transpportation
Protfolio optimization
Network models
Inventory control, production planning and scheduling
Sustainable manufacturing
Robotics in manufacturing
Modeling, simulation, control and monitoring of manufacturing processes
Logistics, supply chains and networks
Facility planning and materials handling
Energy systems modelling
Design and reconfiguration of manufacturing systems

Control Theory & Applications

Kemal Leblebicioglu, METU, Turkey
Metin Demirtas, Balıkesir University, Turkey
Beyza Billur Iskender Eroglu, Balikesir University, Turkey

Theme

This session aims to discuss a broad range of topics including current trends of linear, nonlinear, discrete and fractional control systems as well as new developments in robotics and mechatronics, unmanned systems, energy systems with the goal of strengthening cooperation of control and automation scientists with industry.

Topics

Adaptive control
Linear and nonlinear control systems
Optimal control
Discrete time control systems
Robust control
Fractional order systems and control
Chaotic systems and control
Evolutionary and heuristic control
Robotic control
Energy management and control
Control of unmanned air and undersea vehicles

A Linear Approximation Model for a Non-Linear Flow Shop Scheduling Problem with Learning Effect

Augusto Ferraro[1], Daniel Alejandro Rossit[1-2] ✉, Adrián Toncovich[1]

[1] *Engineering Department, Universidad Nacional del Sur, Bahía Blanca, Argentina*
[2] *INMABB, CONICET, Bahía Blanca, Argentina*

Abstract

Learning effects have been considered in operations management problems since the early twentieth century [1]. The learning effect has a direct influence on production scheduling problems, since it modifies the use of production machines [2], and for this reason, it has been a problem widely studied by the scheduling community [3]. However, modeling the learning effect in scheduling problems by means of mathematical programming requires the use of non-linear expressions [4], this has limited the majority of works to be focused on single-machine problems [2] [5]. In this work, it is proposed to extend these formulations for the case that the learning effect is exponentially dependent on the previous jobs processed in the sense of [5]. This mathematical model is clearly non-linear, and by having several machines in which the learning process occurs, the probability of getting trapped in poor local optimums is very high. The proposal of this work is a linear approximation scheme, which can be implemented by a standard MIP solver such as CPLEX, in order to obtain very high quality solutions, without requiring sophisticated and tailored methods. The approximation scheme is based on a set of straight lines, which approximate the expected learning effect, generating a convex shell to the problem with expected values, thus avoiding falling into poor quality local optimal points. For creating the convex shell, a least-squares problem must be solved, which is also non-linear, but does not require integer variables, then, it can be solved by simple solvers like the ones provided by spreadsheet software. To evaluate the capability of the solution scheme, the proposed linear model solution was compared with the solution obtained by a proven MINLP solver such as DICOPT [6], in flow shop problems with makespan as the objective function. The results show that the proposed scheme notably improves the solutions obtained by DICOPT, reducing the makespan in up to 12%.

Keywords: flow shop, learning effect, non-linear mixed integer programming, linear approximation

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