



Proceedings of
International Conference on
Applied Mathematics
& Computational Sciences



Editors

Jogendra Kumar
Seema Yadav
Fateh Singh

17–19 October, 2019



Organized by
DIT University, Dehradun, India

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Jogendra Kumar
Seema Yadav
Fateh Singh
(Editors)

Proceedings of

International Conference on Applied Mathematics & Computational Sciences

ICAMCS-2019 (17th – 19th October, 2019)

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Proceedings of
International Conference on Applied Mathematics & Computational Sciences
(ICAMCS-2019) (17th-19th October, 2019).

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Foreword

It is a great privilege for us to present the proceedings of ICAMCS2019 to the authors and the delegates of the event. We hope that you will find it useful, valuable, aspiring and inspiring. Proceedings is a published record of papers presented by the participants, which indicates the progress and state of development in research at the time of writing the research article. It is an invaluable asset to all researchers. Proceedings provide a permanent record of this asset.

ICAMCS2019 aimed to provide a platform to discuss ideas, issues, challenges, findings, opportunities and applications of Applied Mathematics and Computational Sciences in various fields. The ever-changing scope and rapid development of science and technology creates new problems, raises questions and curiosity, thus making it mandatory to share brilliant ideas and stimulate awareness of this vital research field in diverse directions. We promise to produce a bright picture and charming landscape for Mathematics with Computer Science. The overwhelming enthusiastic support received have truly exceeded our expectations. And thus, on the day of completion of this journey, we are delighted with a high level of satisfaction and aspiration.

The response to the call-for-papers had been overwhelming – both from India and overseas. More than 110 participants actively participated in the conference across nation and abroad viz. Nepal, Bangladesh, Nigeria, Slovenia, Yemen, Jordan and Zimbabwe.

We are indebted to and extend our gratitude to the chairman, academic advisors and technical advisors whose support made the conference successful. We extend our gratitude to eminent guest speakers whose valuable ideas brought the conference to a higher level and made this conference meaningful and a great success.

We would also like to express our gratitude and appreciation to all the reviewers who helped us in maintaining the high quality manuscripts for the proceedings, being published by AIJR publisher. Unfortunately, many manuscripts from prestigious institutions could not be accepted due to the reviewing outcomes.

We are optimistic about getting the proceedings of ICAMCS2019 with high visibility and with cross reference. We also appreciate the efforts of the authors of ICAMCS2019. We try our best to maximize the popularity of their papers and wish them for their future endeavors.

We would also like to extend our thanks to the members of the organizing team for their hard work.

We hope that all the participants of ICAMCS2019 had a wonderful and a fruitful time at the conference and that our oversea guests had comfortable stay and enjoyed the beautiful weather of Dehradun city.

Dr. Jogendra Kumar
Ms. Seema Yadav
Dr. Fateh Singh
(Editors)

About ICAMCS -2019

Applied Mathematics is the branch of Mathematics that focuses on developing mathematical methods and applying them to science, engineering, industry and society. It includes mathematical topics such as partial and ordinary differential equations, linear algebra, numerical analysis, operations research, discrete mathematics, optimization, control system and probability & statistics. A large number of real-life problems can be formulated in terms of mathematical expressions, which often cannot be solved analytically. This leads to development and formation of new tools & techniques. To name a few of them are probability, statistics and numerical methods. Probability & Statistics is a body of methods for making wise decisions in the face of uncertainty. Probability theory when combines with computational statistics forms the base of Evolutionary Genomics. Applied mathematics uses mathematical modeling techniques to solve real-world problems and have tremendous applications in sciences, engineering, commerce, education, social sciences, business, politics & many more. Applied Mathematics develops skills in problem solving, critical & logical thinking, modeling, learning, analysis, research and creativity.

Computational science is an emerging discipline which focuses on integrating applied mathematics, computer science, engineering and the sciences. This creates a multidisciplinary field which utilizes computational tools and simulations to produce problem-solving techniques and methodologies. Every area of cutting-edge science uses computational science techniques. It has a wide range, a few of them are: understanding of sub-atomic particles, knowledge of processes of formation of stars & galaxies, molecular basis of life, governing processes of outbreak of epidemics, sustainability of ecosystem & dynamics of biosphere. Computational science starts with theoretical and practical fundamentals of computer science & algorithmic problem solving and it goes to advanced programming techniques, 3D computer graphics & intelligent systems. Computational science has become a third partner, together with theory and experimentation, in advancing scientific knowledge and practice.

Applied Mathematics and Computational Science together are utilized in almost every discipline of science, engineering, industry and technology. This amalgamation opens a door to a variety of fields including finance, computing & insurance, industries, medical, research & development, public service, design and manufacture of aircraft, automobiles, textiles, communication systems, biological-physical-mathematical & biomedical sciences, sciences related to earth-atmosphere-environment and many more.

This interdisciplinary area even develops new disciplines in humanities & creative arts. Computational techniques are becoming increasingly relevant in the field of social sciences, archaeology, architecture, music & visual art.

Working with mathematics often leads to the development of new mathematical models, theories and applications that contribute to diverse areas of science. There is a need to have deliberations and discussions over the challenges, recent developments and applications while developing mathematical models in various disciplines.

In a nutshell, this interdisciplinary fusion provides a core of mathematics and an introduction to concepts & techniques of computation, optimal decision making, probabilistic modeling & statistical inference. Mathematics and Computational Sciences have an important role in inter-related fields and hence, there is a

need to have deliberations over various aspects and recent developments in these interdisciplinary areas. Therefore, the main objective of this International Conference is to bring together the learned academicians, scientists and research scholars, working in various areas of Mathematics and Computer Science, worldwide and initiate dialogue among them through various sessions.

The conference will feature keynote address, a number of plenary talks, invited lectures, contributory lectures and poster presentations. The conference is focused on the following research areas of Mathematics & Computer Science:

- Mathematical Modelling, Mathematical Biology and Mathematical Medicine
- Differential Equations, Quality Theory of Differential Equations, PDEs, Dynamical Systems
- Biomechanics
- Stability of Flows, Fluid Mechanics
- Numerical Solution ODEs, Numerical Solution PDEs (inc. BVPs)
- Stochastic Differential Equation, Approximation
- Numerical Linear Algebra, Numerical Integral Equations
- Error Analysis and Interval Analysis
- Difference Equations and Recurrence Relations
- Numerical problems in Dynamical Systems, Numerical methods in Fourier analysis etc.
- Differential Algebraic Equations
- Industrial Mathematics, Discrete Applied Mathematics, Experimental Mathematics
- Applied Algebra
- Computational Statistics, Statistical Inference, Demography, Bayesian statistics, Probability
- Computational Physics, Mathematical Physics, Theoretical Mechanics
- Computational Chemistry, Mathematical Chemistry
- Optimization and Operational Research
- Continuous and Discrete Wavelet Transform
- Bifurcation and Singularity Theory
- Deterministic Chaos and Fractals
- Computational Engineering
- Algorithms
- Theoretical Computer Science
- Decomposition and Reconstruction Algorithms, Subdivision Algorithms
- Complexity Theory and Neural Networks
- Computational Intelligence (Neural Networks, Fuzzy Systems, Evolutionary Computing)
- Data Structures, Operating Systems
- Parallel and Distributed Systems
- Scientific Computing and Algorithms
- Numerical and Semi-Numerical Algorithms
- Control Theory and Automation
- Neural Networks, Genetic Algorithms, Game Theory

About the Host University

DIT was established in 1998 as Dehradun Institute of Technology by Unison Group, which later was given the status of autonomous body in 2012 by UGC. Further, in 2013 it was conferred the status of University under act no. 10 of 2013 by Uttarakhand State Government and recognized by UGC under section 2(F) of UGC act, 1956 due to its excellence in Education and Research. The University offers various programs at undergraduate and postgraduate level which includes Engineering, Pharmacy, Architecture, Management, Science and Humanity & Liberal Arts Courses.

About the Department of Applied Sciences

Department of Applied Sciences was established in 2013 under the aegis of DIT University with a vision to be an epicenter of learning, teaching and research for Mathematics, Physical and Chemical Sciences. The department offers BSc (H), MSc, and PhD Programs in Physics, Chemistry and Mathematics. The curricula for all the courses are designed in consultation with experts from industry and academia to match the highest standards of the best of the institutes across the globe. We foster our students with a strong foundation which enables them to deal with real world problems using an interdisciplinary approach.

About the City Dehradun

Nestled in the Doon Valley in the foothills of the great Himalayas and flanked by two very beautiful as well as mighty rivers the Ganges and the Yamuna on its eastern and western side, Dehradun is one of the most ancient cities of India. Serving as capital city of Uttarakhand, Dehradun got its name by the union of two words 'Dera' and 'Dun' that means Camp in the Valley.

Dehradun is a trendy hilly tourist destination with its impeccable beauty and charismatic sceneries. Along with tourist spots, famous scientific museum and lush green sprawling parks, Dehradun is adorned with several famous historic buildings that have great architectural value and a number of temples that have spell binding beauty and at the same time are considered to be very auspicious.

The weather in Dehradun in the month of October remains pleasant with temperature varying between 17 °C to 29 °C. The city also receives a good amount of snowfalls during winters which is a major attraction of tourist.

About the Volume Editors

Dr. Jogendra Kumar



Dr. Jogendra Kumar is currently working in the Department of Applied Sciences (Mathematics) at DIT University, Dehradun. He has over 11 years of experience in Academia. He has completed his M. Sc. and Ph.D. from Banaras Hindu University. His Ph. D. work was focused on the study of Thermal Instabilities in Incompressible Fluids saturated with Porous Media. He obtained his B. Sc. in Mathematics from K.N.P.G. Degree College, Gyanpur affiliated to V. B. S. Purvanchal University, Jaunpur. Dr. Kumar has organized number of National & International Conferences sponsored by SERB India, CSIR New Delhi & UCOST Uttarakhand. Dr. Kumar also organized workshops/ FDP's in collaborations with renowned Institutions like IIT Bombay and Banaras Hindu University etc. Dr. Kumar has published research papers in peer reviewed Journals of International and conferences of National and International repute.

Ms. Seema Yadav



Ms. Seema Yadav is currently working in the Department of Applied Sciences (Mathematics) at DIT University, Dehradun. She did her M.Sc. from Hemwati Nandan Bahuguna Garhwal University (A Central University), Srinagar (Garhwal), Uttarakhand. Currently, she is pursuing Ph.D. from DIT University, Dehradun. Ms. Yadav is having reach teaching experience of 16 years and she has published research papers in peer reviewed Journals of National / International and conferences of National and International repute.

Dr. Fateh Singh



Dr. Fateh Singh is currently working in the Department of Applied Sciences (Mathematics) at DIT University, Dehradun. He has over 5 years of experience in Academia. He has completed his Ph.D. from Department of Mathematics, IIT Roorkee, India. He obtained his B.Sc. and M. Sc. from Department of Mathematics, CCS University Campus, Meerut, India. His Ph.D. work was focused on mathematical modeling (Bio-mechanics). Dr. Singh has published several research papers in peer reviewed Journals of National / International.

Message from Chancellor Desk



It is a matter of pleasure and pride that Department of Applied Sciences (Mathematics), DIT University organized an International Conference on Applied Mathematics and Computational Sciences (ICAMCS 2019) from 17th – 19th October 2019. The objective and focus of the Conference was to have fruitful discussion amongst academicians, researchers and experts of different fields. I do hope that this forum has shown us ways to develop novel mathematical techniques, methods and models which can be applied in different fields of Science, Engineering

and Technology; which ultimately leads to development of society and the nation.

I am happy to note that the discussions and deliberations during the conference is to be published in the form of Proceedings by AIJR Publisher, India. I trust that it will be a useful reference.

I appreciate the efforts of the Organizing Committee and all Members involved in publishing the proceedings.

N. Ravi Shanker
30/7/2020.
(N. Ravi Shanker)

Message from Vice Chancellor Desk



I am happy to know that the Proceedings of the International Conference on Applied Mathematics & Computational Science from October 17-19, 2019 organized by the Department of Applied Science (Mathematics) DIT University, Dehradun is being published by AIJR publisher, India.

We had active participation of distinguished key note speakers and participants at International level. This publication vindicates the quality of discussion & deliberation held during this conference. I am confident that these research funding will be valued by one and all. This conference has promoted the quality of intellectual curiosity and its implementation amongst the society.

I appreciate the efforts of organizing committee in bringing out this proceeding.

(Prof. K. K. Raina)
Vice Chancellor

Message from the Pro-Vice Chancellor



It is indeed a proud moment and a great honour to have hosted the International Conference on Applied Mathematics and Computational Sciences-2019 (ICAMCS-2019) at our campus. This convention was scheduled appropriately with the intent to focus on developing mathematical methods and applying them to science, engineering, industry and society. The subsequent, intellectual discussions and deliberations reflect the true prowess and essence of the subject in day to day life.

The theme, had invoked intriguing dialogues and encouraged all participants to contribute towards the Global perspective and our National Interest in this field. The congregation of eminent speakers both of National and International fame resulted in exchange of ideas and immense networking. Ultimately, this facilitated us to developing a potent policy with achievable targets. Compendiums & Reports of such Conferences truly indicate that importance of Mathematics as the “Engine” in Engineering and Sciences.

I congratulate the organizing committee and all members for their concerted efforts in consolidating these visionary proposals and publishing a document for posterity. Our best wishes for a new resolve to ensure that this compilation of productive and intelligent discussions commits to memorable outcomes.

A handwritten signature in blue ink, reading "M. Srinivasan". The signature is written in a cursive style with a long horizontal stroke at the end.

Brigadier (Dr) M Srinivasan
(Retired)
Pro Vice Chancellor

Message from DSW



It is a matter of pride that Department of Applied Sciences (Mathematics), DIT University is organizing this International Conference on Applied Mathematics and Computational Sciences (ICAMCS-2019) during October 17 – 19, 2019.

This conference expresses the unity of two different yet concurrently moving areas and provides a platform to researchers and academicians to come together to share and spread their knowledge, which is the need of the time. With the untiring efforts of our faculty, we have tried to bridge the domain of Applied Mathematics and Computational Sciences.

This interdisciplinary area is of ever-increasing importance in Science & Technology and go hand in hand when proper rationality is maintained. Department plays an important role in disseminating the quality education and encourages the research and enhances various mathematics related programs at DIT University. I hope this conference will achieve its goal and wish a great success.

A handwritten signature in black ink, appearing to read 'Rakesh Mohan'.

(Dr. Rakesh Mohan)
Dean Student Welfare

Message from Convener



I am delighted that ICAMCS-2019 is being organized at DIT University, Dehradun with all its glory. Conferences are providing opportunities for researchers and faculty members and students for networking and collaboration among the peer groups along with publications in a peer reviewed journals/proceeding.

I am sure this Conference will provide an opportunity for the participants to share their knowledge and get updated. We are living in a time where boundaries of knowledge are being advanced at a rapid pace, this Conference will help to chart new stream of research for sure. I have observed a steady rise in the number of quality manuscripts being received in the conference. Major cornerstone of the conference is the

number of key persons/researchers interested for key notes and discussions in the conference. I thank the support of all authors, reviewers, DITU faculties for making the conference a success. I expect that ICAMCS 2019 will prove a memorable and productive discourse for all those who are a part of this event.

Finally, I would like to thank AIJR publisher for their consent to publish Conference Proceedings and UCOST, Uttarakhand for their financial support to organize this conference.

A handwritten signature in blue ink, consisting of stylized initials and a surname, positioned above a horizontal line.

(Dr. Jogendra Kumar)
Convener, ICAMCS-2019
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