From the Editor's Desk

After the Journal got transformed into its new *Avatar* in 2007, we had very interesting issues devoted to current research topics such as micro and nano technologies, recent trends in crystallographic research in India and recent developments in mathematical sciences. Our Guest Editors, editorial staff, contributors, reviewers, and the staff members in the Journal office did a wonderful job of putting together these special issues.

We hope to make the issues of 2008 equally exciting. Let me unfold what is in store. It is planned to have an issue devoted to Biological Engineering Guest-Edited by Prof. Jayanth Modak, another one on Crystallographic Research in India Guest-Edited by Prof. T. N. Guru Row, and an issue on Materials Guest-Edited by Prof. Vikram Jayaram. The Centenary Celebrations will be something special for every one connected with the Institute. As a mark of special attention to this event, an issue of the Journal will be brought out by a select committee identified for this purpose.

It is refreshing to note that we have a large number of enthusiastic volunteers coming forward to Guest-Edit special issues on various topics of current interest. I hope that our Journal will be a trend setting one in bringing out issues covering excellent review articles on various topics of current and future interest.

Hope our readers enjoy this special issue on recent developments in mathematical sciences, guest-edited by one of our distinguished colleagues, Prof. G. Rangarajan.

Warmest greetings from me to our readers and their family members for a wonderful year ahead.

L. M. Patnaik
Editor

Editorial

There has been tremendous progress in mathematical sciences over the past decade. Traditional boundaries between various areas of mathematics are slowly disappearing. The eclectic mix of invited talks witnessed at the recent International Congress of Mathematicians is a testament to this fact. This special issue is an attempt to capture a small slice of the diverse mix of research currently being carried out in mathematical sciences.

The article by B. Datta is a review on vertex-minimal triangulations of manifolds. Together with the works on vertex-minimal triangulations of piecewise-linear manifolds of last 30 years, several examples of vertex minimal triangulations and some open problems are presented here. This article also includes a very brief history of triangulations of manifolds. All definitions which are relevant to this article are included in the beginning.

The proof of the Poincare conjecture by Grisha Perelman in 2002 is a major milestone in mathematics. This was based on the study of a certain evolution equation, the Ricci flow, invented and developed by Richard Hamilton. In the article by S. Gadgil, the main goal is to view this work in a broader perspective of dynamical systems. This article is an attempt to understand the special features of the Ricci flow in dimension three that are used in Perelmans work, or equivalently to get some sense of the generality in which Perelman's methods apply.

The article by B. Sury is an exposition on the 'congruence subgroup problem'. This subject is at a common ground shared by group theory and number theory. It deals with certain groups defined arithmetically and their subgroup structure. This is a relatively modern subject having taken off in the mid 1960's after Klein's early investigations on the modular group. Apart from interest in its own right, the subject gains importance also because of connections with the theory of automorphic forms which is central to number theory. This exposition is meant to introduce the subject to professional mathematicians working in other areas. At the end, some recent work by the author is mentioned.

The article by R. P. Sarkar and S. Thangavelu shows that the Wiener Tauberian property holds for the Heisenberg Motion group $\mathbb{T}^n \triangleright\!< H^n$. Their exposition is almost self-contained and the techniques used in the proof are relatively simple.

The article by A. K. Nandakumaran presents a short survey of homogenization of partial differential equations. A possible definition of homogenization would be that it is a process of understanding a heterogeneous (in-homogeneous) media, where the heterogeneities are at the microscopic level, like in composite materials, by a homogeneous media. In other words, one would like to obtain a homogeneous description of a highly oscillating in-homogeneous media. This theory is relatively new area and has tremendous applications in various branches of engineering sciences like: material science, porous media, study of vibrations of thin structures, composite materials to name a few. Though the material scientists and others had reasonable idea about the homogenization process, it was lacking a good mathematical theory till early seventies. An introductory presentation with the aim of catering to a wider audience is given in the article. A few examples are introduced to understand homogenization procedure in a general perspective together with applications. Various mathematical techniques are also presented. The generalizations to non linear problems carried out with my collaborators are also presented. Finally, a closely related issue, known as optimal bounds (which by itself is an independent area of research) is discussed.

Controllability is one of the basic notions of fundamental interest in engineering systems. A system is controllable if it is possible to steer the state of the system from any arbitrary initial state to any desired final state during a specified time interval using available external controllers. The present article by R. K. George and T. P. Shah deals with controllability analysis of a class of semilinear discrete-time systems with finite dimensional state-space. It has been shown that the controllability properties of the semilinear system is dominated by the controllability properties of the linear system provided that the nonlinearity in the system satisfies a Lipschitz condition and some restriction on the growth of the nonlinearities. An algorithm for the computation of the steering controller is obtained. Tools like fixed point theorem from functional analysis are made use of.

The paper by S. K. Iyer describes the evolution of a system of particles that move randomly in space, live for a random amount of time and give birth to a random number of offspring, each of the randomness characterized by certain prescribed probability distributions. Such processes are of interest in population and genetic models, and more recently as approximations to rescaled voter models and critical oriented percolation models. It is proved that such systems can be rescaled so that in the large density, small mass and rapidly branching limits they converge to a smooth process whose evolution and properties are easier to study.

The article by H. Nalatore, W. Trucollo and G. Rangarajan reviews one aspect of the brain-machine interface (BMI) problem. The main goal of BMI is to control a prosthetic device using brain activity. One of the key mathematical techniques used in BMI is pattern classification. This article gives a brief review of pattern classification algorithms based on discriminant analysis. These algorithms are then applied to classify movement direction based on multivariate local field potentials recorded from a microelectrode array in the primary motor cortex of a monkey performing a reaching task.

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