

Advances in mathematical, statistical and computational methods in science and technology*

Mathematical, statistical and computational methods play a vital role in the progress of science and technology (S&T). Challenges in S&T and practical problems of classical fields like physics, chemistry, engineering, biology, banking, medicine and many recent industrial and environmental tasks can be met through these methods. Theoretical development, which is needed, would lead mathematical sciences to profit from these new challenges. The objective of the seminar was to bring together the academicians, scientists, engineers, technologists and mathematicians working in various organizations with a view to amalgamate the ideas in many a mind, and to sharpen the techniques and tools used to meet the challenges. The prospect of a growing applicability of applied mathematics/statistics/optimization/computational techniques to various disciplines of S&T was highlighted in the seminar.

About 80 mathematicians, scientists, professionals, teachers and research scholars from various universities, institutions and colleges participated in the two-day seminar. Technical programmes included invited lectures, contributed papers in three parallel sessions and a panel discussion. There were mainly five categories of abstracts, which were organized as (numbers within parenthesis indicate papers presented under each category): (i) Mechanics of solids and fluids (27), (ii) Statistical methods in industry and technology (11), (iii) Mathematical modelling and ecology (14), (iv) Operation research and optimization techniques (13), and (v) Numerical and computational techniques (15). Selected important papers of the seminar will be published after review in a book form. The seminar was supported by AICTE, CSIR, DST and ISM.

The inaugural session of the seminar was presided by B. B. Bhattacharya (Director, Indian School of Mines (ISM), Dhanbad) who discussed the importance of the seminar and role of the Department of Applied Mathematics as well as of ISM in handling the problems of S&T in various fields. A. N. Basu (Vice-Chancellor, Jadavpur University) in his inaugural address discussed the past, present and future challenges for applied mathematics. He discussed three unsettled problems of mathematics: (a) Fermat's problem ($X^n + Y^n = Z^n$, $n > 2$) which was settled in 1993 by Wiles; (b) Kepler's sphere-packing problem, for which in 1960, Thomas Hales provided a solution and suggested that hexagonal packing is the best option, and (c) Four colours problem in which the infinite possibility problem reduces to finite possibility problem. He discussed the dual nature of mathematics and remembered G. Hardy's comment that: 'I do some work which has no application'. But after a long time some results of Hardy are used in physics. The development of different fields of mathematics contributed a lot to the development of S&T. Some of these fields are: (i) Riemann geometry (Einstein's general theory of relativity is based on this theory); (ii) Group theory (cryptography, quantum mechanics and communication networking); (iii) Nonlinear science, soliton solutions ($K-dV$ equation, wave theory and oceanography); (iv) Bifurcation theory and deterministic chaos (proper adjustment of bifurcation parameter gives chaos); (v) Concept of fractal (infinite details at every point and certain self-similarity between the object parts and overall features of the object); (vi) In the area of biological sciences, the HIV model and the relation between virus and immunological system helps drug designers and drug administrators.

He also discussed new challenges like: the Riemann hypothesis of prime numbers, the Poincaré conjecture, the N -body problem and interface of number theory, quantum theory and computers.

Basu said that in spite of many advances made in the last century, these problems still remain essentially open, presenting

incomplete mathematics. According to him, even pursuing some of these potential problems may open up altogether different fields of research and completely new sets of theories, even if one is unable to solve the original problem completely. Finally he concluded his talk with Einstein's comment, 'Where it is accurate it is not relevant, where it is relevant it is not accurate'.

Some of the highlights of the different technical sessions of the seminar are as follows: J. C. Misra (IIT, Kharagpur) discussed recent advances in biomechanics research. He presented an overview of the researches in some major areas like the mechanics of head injury and the mechanics of cardiovascular system. He discussed in detail the rotation and cavitation hypothesis. Since mathematical models play an important role in deriving useful information about the mechanics of different human systems, emphasis will be laid on various studies pertaining to a sizeable number of biomechanical investigations carried out through the use of mathematical models. B. K. Sinha (ISI, Kolkata) talked on 'Data envelopment analysis (DEA): State-of-the-art'. DEA has its origin in environmental problems. He discussed the TOPSIS and ELECTRA method (Hwang-Yoon), reviewed critically the existing DEA measures and proposed some new measures. R. N. Sen (Calcutta University) presented finite difference methods for certain singular, two-point boundary value problems. The method is mainly an extension of the method of Gustafsson from linear to nonlinear differential equations, and is particularly suitable when the differential equation in question cannot be reduced easily to an elegant system of first-order equations. A. K. Sinha (Patna University) presented ranked set sampling (RSS) method to estimate the population mean and other parameters of interest. He made an attempt to explore its applications to carry out scientific and technological investigations with observational economy, which is of particular interest to those who look for a cost-effective survey sampling technique. B. N. Mandal (ISI, Kolkata) introduced water-wave

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scattering problems and associated mathematical techniques. A substantial amount of research work on water-wave scattering by vertical barriers, thin vertical barriers, and thin curved barriers was presented. The implication of the numerical results was discussed in the context of modelling of break waters which are constructed to protect a sheltered area from the rough sea. P. R. Sengupta (University of Kalyani) addressed some problems of mechanics of fluids with special reference to visco-elastic fluids. He also discussed the numerical results to find the maximum velocity of OLDROYDIAN fluid in a circular pipe. S. N. Bora (IIT, Guwahati) talked about second-order wave theory for a circular cylinder in finite water depth. He presented the second-order diffraction problem for the large vertical cylinder. Expressions for three second-order forces, namely waterline force, dynamic force and quadratic force were obtained. The first-order potentials contribute to waterline and dynamic forces, whereas the second-order potentials contribute to the quadratic force. Emphasis was more on the contribution of the second-order forces to the total force. R. Sircar (REC, Durgapur) discussed computer-based modified Fourier algorithm for solving problems in the

industry. He tried to explore the feasibility of applying the modified Fourier method (MFM) in solving linear programming problems with finite number of variables and constraints that are relevant to industrial problems. The MFM algorithm has been successfully implemented in an interactive computer program which also highlights the pros and cons against conventional simplex algorithm. V. Charles (REC, Warangal) discussed a branch-and-bound technique for linear stochastic fractional programming with joint probability constraints. R. K. Upadhyay (ISM, Dhanbad) presented a Gauss-type mathematical model to study the effect of predation on two competing prey species in which the predator species is influenced by the damage effect caused by crowding from the members of its own population in a diffusive system. S. Dey (ISM, Dhanbad) talked on useful mathematics in seismic studies and showed the effect of presence of initial stresses and gravity field on the propagation, reflection and refraction of seismic waves. He also said that non-homogeneous earth allows torsional surface waves to propagate and initiated the idea of construction of seismograms which can record torsional movements. Some selected papers, which appeared in dif-

ferent technical sessions are: (i) Genetic algorithm and its applications (M. Chakraborty and M. Rajasekar, ISM, Dhanbad); (ii) Solving numerical problems on parallel computers (P. K. Jana, ISM, Dhanbad); (iii) On the conservation laws of the magma equations (K. Singh, Hisar); (iv) Software metrics in fuzzy environment (D. Patel, RIT, Jamshedpur); (v) Diffraction of shear waves in a homogeneous medium (B. K. Rajhans, ISM, Dhanbad); (vi) MHD flow in a rotating channel (G. S. Seth, ISM, Dhanbad); and (vii) A new approach to the estimation of population mean in two-phase sampling (G. N. Singh and L. N. Upadhyaya, ISM, Dhanbad).

All in all, the atmosphere was lively and informal, the younger participants had an opportunity to make short presentations. The panel discussion prompted us to think more seriously about the development of new techniques to resolve real problems of the society, and new tasks in S&T.

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New horizons in heterogeneous catalysis*

Processes based on heterogeneously catalysed reactions have become one of the most powerful tools of today's petrochemical and refining industry, and are critical to environmental protection and public health. Advancements in the science and technology of heterogeneous catalysis are, therefore, crucial for the sustainable development of global society. Taking into account the growing significance of the subject, a national symposium on heterogeneous catalysis was organized to advance the knowledge base

and to identify the critical areas for future research. Nearly a hundred participants from within the country attended this symposium.

Inaugurating the symposium A. V. Ramaswamy (NCL, Pune) provided a chronological overview of the outstanding Indian contributions in the area of catalysis since 1927, and said that future challenge of the subject is to achieve 100% selectivity for the desired product. This will enable clean manufacturing with no hazardous waste products. P. Ramachandra Rao (Vice-Chancellor, BHU) in his Presidential address, referred to several important problems such as coking and regeneration associated with industrial catalysis. He also dealt with the potential and future applications of nanocrystalline materials. The construc-

tion of these materials in bulk quantities is at present a challenge, for which an understanding of their surface to volume ratio is of particular importance. He urged for exploiting these materials directly as catalysts without any further treatment or coating.

The scientific programme commenced with the Professor Gopal Tripathi Memorial Lecture-2002 delivered by S. P. Sukhatme (Chairman, Atomic Energy Regulatory Board, Mumbai) who focused his attention to present India's production and reserves of various commercial and non-commercial energy sources. In view of the gradual decline in fossil-fuel reserves, he presented a comparative account of the two major alternative options such as solar energy and nuclear power. The Principal N. N. Godbole

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