



# C. N. R. Rao Lecture

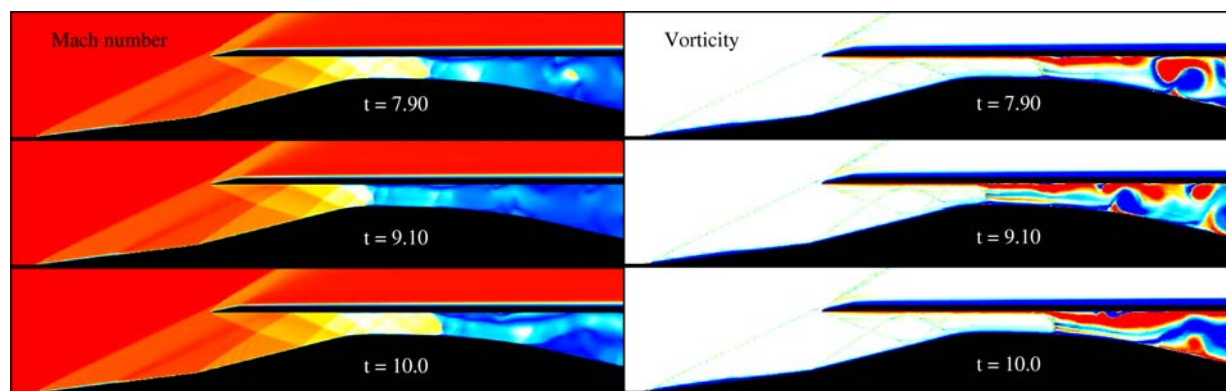
6.00 PM, Monday, 26th March 2012, Venue: L-16

**Professor Sanjay Mittal**  
Department of Aerospace Engineering, IIT Kanpur

**Title: Using High Performance Computing (HPC) for Understanding Fluid Flows**

## Abstract

The presentation will begin with a brief overview of Computational Fluid Dynamics (CFD). A summary of our recent research efforts to understand fluid flows, by using computational tools, will be presented. Our work towards understanding the mechanism of swing and reverse-swing of a cricket ball will be discussed. Questions such as, 'Can a new ball reverse-swing?' will be addressed. We employ modern stabilized finite element methods for solving the governing equations for fluid flows. They are utilized to compute flows at various Reynolds and Mach numbers including those that involve moving boundaries. Some of the flow problems arise from practical applications while others add to understanding of certain fundamental issues in fluid mechanics. Most of the applications require large scale computing. To that extent, where-ever possible, in-house codes have been parallelized using MPI libraries. Scalability on parallel computers is demonstrated. Parallel implementations on the Linux cluster have resulted in super-linear speed-up. One of the several problems studied is the flow in an air-intake of a high speed engine. A mixed compression intake for a Mach=3 flow is considered. Viscous effects as well as boundary layer bleed are modeled. The buzz instability is observed in certain cases. Both, little and big buzz are found. Their frequency is related to the super-harmonics of the intake duct which acts as an open-closed organ pipe. The role of bleed in controlling the buzz oscillations is studied. A brief overview of our work on understanding wakes of bluff bodies will be presented.



## About the Donor

Chintamani Nagesa Ramachandra Rao was born on June 30, 1934 in Bangalore. In 1958, he completed his Ph.D. from Purdue University and he became a research chemist at the University of California at Berkeley. Returning to India in 1959, he worked as a lecturer at the Indian Institute of Science in Bangalore. From 1963-76, he was a Professor of Chemistry at IITK. During 1984-89, he was the Director of IISC Bangalore.

Dr. Rao has published more than 45 books and 1500 research papers with more than 42,000 total citations. Concurrent with his academic excellence, he was appointed as Chair of the Scientific Advisory Council to the Indian Prime Minister in 2005. He has won several international prizes and is a foreign member of the US National Academy of Sciences, American Academy of Arts and Sciences and of the Royal Society (London). He has also been given the high honors of Padma Shri and Padma Bhushan by the Government of India.

The annual C.N.R. Rao Lecture is supported by a generous donation from Prof. Rao.

## Previous Speakers

| Year | Name             | Title  |
|------|------------------|--|
| 2011 | Amalendu Chandra | Molecular simulations of liquids and interfaces: An HPC activity at IITK             |
| 2010 | Gautam Biswas    | Understanding Vapor and Air Bubbles  |
| 2009 | V. Chandrasekhar | Single-Molecule Magnets  |
| 2008 | Manindra Agrawal | The P<>NP Problem  |
| 2007 | R.C. Budhani     | Low-Dimensional Superconducting and Magnetic Material of Proven Technology Relevance |
| 2006 | Kalyanmoy Deb    | Evolution Optimization for problem Solving and Knowledge Discovery                   |
| 2004 | Ashutosh Sharma  | Of Small Things and other Stories  |



## About the Speaker

Sanjay Mittal did his B.Tech from IIT Kanpur in 1988. He received his Ph.D. from University of Minnesota, USA in 1992. He joined IIT Kanpur as Assistant Professor in the year 1994. He became Professor in the year 2003. He has also served as the Dean of Academic Affairs of the Institute.

He received the Shanti Swarup Bhatnagar Prize from Council of Scientific and Industrial Research, GOI, in 2006. He is a Fellow of Indian National Academy of Engineering and Indian Academy of Sciences.

His research interests include unsteady aerodynamics, laminar separation bubbles on airfoils, aerodynamic shape optimization, fluid-structure interactions, bluff body flows, linear stability analysis, buzz instability in air intakes, aerodynamics of sports balls, train aerodynamics, traffic modeling and high performance computing.

**Contact: Dean of Research & Development**