



## Special issue dedicated to honoring the memory of Professor Dr. A.V. Balakrishnan

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**Fig. 1** Professor Dr. A.V. Balakrishnan

<sup>2010</sup> **Mathematics Subject Classification** 74F10; 74H40; 34D45; 35M32; 74B20; 74K20; 76G25; 76J20; 35G05; 35G10; 35Q74; 45C05; 45F15; 45K05; 93A10; 93D05; 93D20; 91A25; 91A15; 91A05; 0H30; 34D20; 26D10; 39A10; 82C21; 92H30; 93E15.

**Keywords:** Applied mathematics, control theory, aerodynamics, stability theory, optimal control, fractional powers, applied functional analysis, stochastic optimization, operator semigroups, modeling, turbulence, aero-elasticity, Kalman filtering theory, state space theory of systems, random processes.

## Preface

Professor A.V. Balakrishnan was born on December 4, 1922 in Palgat, India. He earned his M. S. Degree in Electrical Engineering and his Ph.D. in Mathematics from the University of Southern California in 1950 and 1954, respectively. From cinema to aerodynamics, he never imagined he would wind up in aerodynamics. Bal grew up in Chennai (Madras), India. He earned his B.Sc. and an M.A. from the University of Madras in the early 1940s and won a scholarship competition from the Indian government to study in the United States and learn to produce documentaries.

He mentioned in his own words: "The problem was that the job they had waiting for me at the Indian Institute of Science just didn't measure up to the opportunities I knew I would have with a Ph.D. in the U.S. So I stayed." After earning his Ph.D. in 1954, he went to the East Coast and worked in radar at The Radio Corporation of America (RCA) for two years. He also mentioned, "That was a hotbed of activity at the time, but I didn't want to stay in Camden because it was known only for Campbells soup, he laughed. Instead, I joined the wagon going west, like so many other engineers did."

Professor Balakrishnan's contributions to applied mathematics, control theory and aerodynamics spanned several diverse areas: From his revolutionary and highly influential Ph.D. dissertation on fractional powers of operators, written under mathematical giant Ralph S. Phillips in 1954 at the USC; to his contributions in both deterministic and stochastic control and communication; to his ingenious Springer-Verlag book on Applied Functional Analysis of 1976 and the second edition of 1981, written with a focus on stability theory, optimal control theory and stochastic optimization for systems defined by operator semigroups, one of his favorite topics; all the way to the last phase of his research activities in continuum aero-elasticity.

Starting in 1961, Professor A.V. Balakrishnan's academic activities evolved mostly at the University of California Los Angeles (UCLA) as Professor of Engineering since 1962 and as Professor of Mathematics since 1965. During 1969-1975 and 1980-1983 he was Chairman of the Department of Systems Science in the School of Engineering, and from 1986 until he passed away he was Director of the NASA-UCLA Flight Systems Research Center.

Of gentle and well-disposed personality, ready to help junior faculty and students, he had a very unique maverick approach to science and life in general, while keeping a strong sense of independence of mind, spirit and action. Indeed, during the severe stages of the cold war, he was able to maintain scientific contacts with the former Soviet Union by inviting Soviet mathematicians such as Leon S. Pontryagin and others to visit UCLA. With Leon S. Pontryagin, Jacques-Louis Lions and Gurii I. Marchuk, he funded the Springer-Verlag journal Applied Mathematics and Optimization and gave birth to IFIP's TC7 Committee on Modeling and Optimization which was spearheaded simultaneously in Rome (Jacques-Louis Lions and A.V. Balakrishnan) and Moscow (Gurii I. Marchuk and Leon S. Pontryagin) in 1963.

Professor Balakrishnan was chairman of the IEEE's Information Theory Group and during 1970-1980 he chaired the Technical Committee on System Modeling and Optimization as U.S. Delegate, and the International Federation on Information Processing (IFIP). From 1980 until 1995 he was Chair of the Working Group 7.1 on System Modeling and Optimization at IFIP. From 1984 until he passed away he was Chairman of the IEEE Subcommittee on Large Space Structures and from 1987 he was President of the ComCon Conference Board. Professor A.V. Balakrishnan had the ability of mastering difficult engineering problems in a rigorous mathematical way and of producing effective engineering solutions. A number of his textbooks have become standard references in their field and

his Department at UCLA became a leading example of school to which talented young students and researchers looked for advice and inspiration. During over sixty years of academic activities, Professor A.V. Balakrishnan lectured as invited professor at many universities and prestigious international conferences. He supervised the work of numerous Ph.D. students and post-doctoral fellows. His research contributions have been published in over two hundred scientific papers, and in over twenty one books published by prestigious publishing houses. Professor A.V. Balakrishnan made important contributions in the areas of Communication Theory, Stochastic Differential Equations, Kalman Filtering Theory, State Space Theory of Systems, Random Processes Theory in Engineering, Laser Propagation in Atmospheric Turbulence, Functional Analysis, Semigroups of Operators Theory, and other areas.

Professor A.V. Balakrishnan also lent his expertise to industry and the government, including to Optimization Software, Inc.; NADC US Navy; and to the NASA Dryden Flight Research Center. He held patents on the modes of interconnected lattice trusses using continuum models and laser beam log amplitude temporal scintillation spectrum due to crosswind. The work of Professor A.V. Balakrishnan has been a source of inspiration for generations of engineers and applied mathematicians. In more than sixty years of an outstanding scientific career, he made seminal contributions to the analysis and design of control systems. His contributions span from the theory of optimal control (where in the 60s, he developed a celebrated method the epsilon technique for the computation of optimal controls for distributed parameter systems), to filtering and identification theory, to a number of very difficult engineering applications which include the control of aircraft under wing turbulence, the control of flexible structure in space and aero-elastic modelling of aircraft wings.

The editorial activities of Prof. A.V. Balakrishnan were impressive as well. He was the founding editor of three important journals: Journal of Computer and System Science (1968 at Academic Press), Journal of Applied Mathematics and Optimization (1968 at Springer-Verlag), *Selecta Mathematica Sovietica* (1981 at Birkhauser) and he was the editor of the following three book series: Applications of Mathematics (Springer-Verlag since 1974), Lecture Notes In Information and Control (Springer-Verlag 1976-1986), and Translations Series in Mathematics and Engineering (Optimisation Software, Inc. Publications since 1983). He served as the coeditor-in-chief of the journal Mathematics in Engineering Science and Aerospace from its very beginning.

Professor A.V. Balakrishnan's professional contributions were appreciated by the international mathematical and electrical engineering communities. He was elected an IEEE Life Fellow for contributions to communication theory. He was honored with the Silver Core Award of IFIP (1977); the Certificate of Recognition of NASA (1978) for flight-test data reduction; the Guillemin Prize (1980) in recognition of the major impact that his original contribution have had in setting the research direction of communications and control; the Group Achievement Award of NASA Langley Flight Research Center (1986) for spacecraft control laboratory experiment; the Honorary Superior Accomplishment Award of NASA Langley Research Center (1992), the Public Service Medal (1996) in recognition of exceptional continuous theoretical and administrative contributions in establishing the UCLA-NASA Flight Systems Research Center to create increased research interactions between the university community and NASA; the Richard E. Bellman Control Heritage Award (2001), an American Automatic Control Council Award, given for distinguished career contributions to the theory or application of automatic control. The award is the highest recognition of professional achievement for US Control Systems engineers and scientists; and the Distinguished Alumni Award in Academia (2004) - Viterbi School of Engineering at University of Southern California.

The impact of Professor Balakrishnan's professional contributions were and still are discernible at many universities. People who prepared for their Ph.D. in control theory in 1970-1975 took full advantage of his results obtained in this area. There are also today young colleagues who have already or will defend their Ph.D. theses, using Professor Balakrishnan's books as a primary source of inspiration.

Professor Balakrishnan received the title Doctor Honoris Causa from the West University of Timișoara, Romania in June 2004.

The Science, Engineering and Aerospace community mourns an icon, a colleague, and a friend. Bal is survived by his unwaveringly supportive and beloved wife Sophia (Sonya) Balakrishnan, and five children from his first marriage.

This special issue contains papers prepared by colleagues, friends, and students of Professor A.V. Balakrishnan, and closely related to his research areas. It is a great pleasure and honor to present the special issue of the Mathematics in Engineering, Science and Aerospace dedicated to Professor A.V. Balakrishnan to the readers.