UNIVERSITÀ DEGLI STUDI DELL'AQUILA
M&MOCS
International Research Center on
MATHEMATICS AND MECHANICS
OF COMPLEX SYSTEMS

J.N. Reddy is selected to receive the Eugenio Beltrami Senior Scientist Prize

J.N. Reddy currently holds the titles of Distinguished Professor, Regents Professor, and Oscar S Wyatt Endowed Chair in J. Mike Walker '66 Department of Mechanical Engineering at Texas A&M University, College Station, Texas, USA. He received a B.E. (Mech) in 1968 from Osmania University, Hyderabad, India; a M.S. (Mech) in 1970 from Oklahoma State University, Stillwater, Oklahoma; and a Ph.D. (Engineering Mechanics) in 1974 from University of Alabama in Huntsville under the guidance of Professor J.T. Oden, former founding Director of (now J.T. Oden's) Institute for Computational Engineering and Sciences at University of Texas at Austin. He worked for a short period as a Research Scientist for Lockheed Missiles and Space Company in Huntsville, Alabama, before joining the School of Aerospace, Mechanical, and Nuclear Engineering at University of Oklahoma as an Assistant Professor in 1975. He was promoted to Associate Professor in 1978 and Professor in 1980. He joined Virginia Polytechnic Institute and State University as a Professor of Engineering Science and Mechanics in 1980, where he was named the Clifton C. Garvin Endowed Professor in 1986. In 1992, he joined Mechanical Engineering Department at Texas A&M University as the inaugural holder of the Oscar S Wyatt Endowed Chair. He was promoted to University Distinguished Professor in 1998 and recognized as the Regents' Professor in 2010. During the period 2005-2007 (on leave from Texas A&M University), he served as the Head of newly founded Engineering Science Program at the National University of Singapore.

From the days of his association as a Ph.D. student of Professor J.T. Oden, Dr. Reddy has worked on mathematical aspects of mixed finite element formulations of boundary value problems and primal-dual variational principles of mechanics. Both of these works culminated in two widely-known books coauthored with Professor Oden: *The Mathematical Theory of Finite Elements* (Wiley Interscience, 1976) and *Variational Methods in Theoretical Mechanics* (Springer-Verlag, 1980). These seminal contributions continue to be cited. Many, if not all, of the assumed strain and mixed and hybrid finite element formulations are special cases of the 14 primal and dual variational principles outlined in their Springer's book.

At the University of Oklahoma, he worked in the area of composite materials and structures, focusing on shear deformation theories to accurately account for inter-laminar stresses in composite laminates. He systematically developed a variationally-consistent third-order plate theory for composite laminates (*Journal of Applied Mechanics*, 1984). This is the most cited journal paper he has published (over 3350 citations to date). The theory is now commonly referred in the literature as the *Reddy third-order shear deformation theory*. Many later investigators have extended this theory for a variety of composite structural applications. Dr. Reddy went on to extend his shear deformation theory to shells and developed their finite element models. Realizing that all equivalent single-layer theories (including higher-order) do not predict interlaminar transverse stresses accurately and do not allow modeling of delaminations and their growth, he introduced a layerwise theory, which is now termed by some as *the Reddy layerwise theory*. Both of these works are now included in the commercial FE code ABAQUS elements (in the background) at the request of DERA (Defense Evaluation and Research Agency, now known as Qinetic) of UK.

During 2006-2010, Dr. Reddy worked with Professor C.M. Wang of National University of Singapore (now at University of Queensland, Australia) on algebraic relationships between classical and shear deformation theories as well as nanomechanics. Dr. Reddy pioneered, with Professor K.S. Surana of the University of Kansas, the development of least-squares based finite element models for flows of viscous fluids. The phrase "k-version finite element method" was introduced first in their writings. The goal of their study was to develop finite element models that yield solutions that are close to exact to a desired degree. This was a paradigm change in going from C_0-finite elements (which have locking issues when applied to plates and shells) that are commonly used to C_k-finite elements, which are robust and require no "fixes" like reduced integration and stabilization.

Dr. Reddy's current research deals with two major areas. First, he, along with his students (and with Professor Marco Amabili of McGill University), is developing 6- and 12-parameter shell theories for accurate prediction of stresses, buckling loads, and frequencies of laminated composite structures. They have developed a robust shell finite element that is free of locking. Second, he started working for the last decade on non-local and non-classical theories using the ideas of Eringen, Ericson, Mindlin, Koiter, and others. With his colleague Dr. A.R. Srinivasa, he has developed a thermodynamically consistent strain gradient elasticity theory that contains Mindlin's model as a special case. His works with K.S. Surana on non-classical continuum mechanics and Debasish Roy of the Indian Institute of Science on discrete fracture and flow, micropolar cohesive damage, and continuum plasticity of metals from considerations of non-equilibrium thermodynamics are gaining attention. From the number of papers that appeared in the last five years that cite his papers on these subjects, one can conclude that his contributions to the advancement of non-local and non-classical continuum theories are significant, and these works have stimulated interest and provided the basis for new contributions.

Dr. Reddy's contributions to engineering and applied mechanics education are significant and have lasting impact on many generations of engineers. Dr. Reddy is a prolific textbook writer (he has authored and co-authored 21 books), surpassing Timoshenko, who is considered to be the father of applied mechanics in the USA, in the number as well as variety of books authored. His textbooks titled, *Energy and Variational Methods in Applied Mechanics* (3rd ed., John Wiley, 2018) and *Theory and Analysis of Plates and Shells* (2nd ed., CRC Press, 2007) now replace the classical textbooks by Langhaar and Timoshenko. As Professor Art Leissa said in his published review (in *Applied Mechanics Reviews*) of the plates and shell book by Professor Reddy, "This new book by J. N. Reddy digests more than two decades of research by him in plate theories (specially for thick plates and laminated composites), variational methods and finite elements into an excellent textbook which can be used very well by beginning or advanced graduate students, or by many engineers who deal with aerospace, automotive and civil engineering structures. That is, the material is presented carefully and reasonably thoroughly, in language that is easy to follow. This is the best textbook that this reviewer has seen for understanding the most important aspects of plate theory, and containing modern, important aspects of plate theory which Timoshenko hardly could touch upon at all (in some cases they were not yet recognized topics); especially thick plates, laminated composites, and finite elements. And yet Reddy's book accomplishes good, useful introductions to all these topics in a mere 540 pages. For this purpose it is the best book available, in this reviewer's experience. As such it belongs on the bookshelves of every technical library, and every graduate student or engineer seriously interested in plates, and should become a widely used textbook in graduate level courses." His classic authoritative text book, *An Introduction to the Finite Element Method*, just appeared as the 4th edition with substantial changes. It is not an exaggeration to say that a majority of engineers and researchers for the last 4 decades have learned the finite element method from his book. His books on energy methods, finite elements, plates and shells, composite materials, and continuum mechanics serve as excellent textbooks and references. He firmly believes that the hallmark of a successful

engineer is to have a strong grasp of fundamental concepts and a creative-thinking capability to apply the fundamental concepts to solve real-life problems. A close look at the textbooks show that his teaching philosophy is based on motivating readers to fully understand fundamental concepts and mathematical tools necessary to formulate problems of engineering and build solutions to engineering problems. Many of his books are adopted as textbooks and used as references worldwide.

As a result of Dr. Reddy's extensive publications of archival journal papers and books in wide range of topics in applied sciences and engineering, Dr. Reddy is one of the original top 100 *ISI Highly Cited Researchers* in Engineering around world with over **28,600** citations and h-index of 78 as per Web of Science; the number of citations is nearly **69,000** with h-index of 105 and i10-index of 545 (i.e., 545 papers are cited at least 10 times) as per Google Scholar.

Professor Reddy has had a profound international impact and he has been collaborating in research and education with a number of countries, including: Brazil, Canada, China, Colombia, Finland, France, Germany, Greece, India, Italy, Mexico, Norway, Peru, Poland, Portugal, Qatar, South Africa, Spain, Sweden, and U.K.

Dr. Reddy serves on the editorial boards of about two-dozen journals, including *Annals of Solid and Structural Mechanics, Composite Structures, Computer Methods in Applied Mechanics and Engineering, International Journal for Numerical Methods in Engineering*, *International Journal for Numerical Methods in Biomedical Engineering,* and *International Journal of Non-Linear Mechanics*. He is the founding Editor-in-Chief of *Mechanics of Advanced Materials and Structures, International Journal of Computational Methods in Engineering Science and Mechanics,* and *International Journal of Structural Stability and Dynamics* (with C.M. Wang and Y.B. Yang).

Dr. Reddy has been recognized with most significant mechanics medals from various professional organizations. The most recent honors and awards include: The 2019 Timoshenko Medal from the American Society of Mechanical Engineers, The JN Reddy Medal in Mechanics of Advanced Materials and Structures (the inaugural recipient); 2018 The Theodore von Karman Medal (ASCE); 2017 The John von Neumann Medal (USACM); 2016 ASME Medal (ASME); 2015 William Prager Medal (SES); 2014 O.C. Zienkiewicz Award (IACM); and 2014 Raymond D. Mindlin Medal (ASCE). He is an elected member of the US National Academy of Engineering and a foreign fellow of Indian National Academy of Engineering, the Canadian Academy of Engineering, and the Brazilian National Academy of Engineering. A more complete account of Professor Reddy's professional activities can be found at http://mehanics.tamu.edu/

For all exposed reasons the committee, entrusted by the Scientific Committee of the International Research Center MEMOCS with the responsibility of awarding the International Eugenio Beltrami Prize unanimously proposes Professor J.N. Reddy as recipient of the 2019 edition.