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ON NONLOCAL STRESS AND STRAIN GRADIENT THEORIES WITH MATERIAL AND STRUCTURAL LENGTH SCALES

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ABSTRACT

Engineers are "problem solving" people, who develop mathematical models of physical processes and then physically and numerically simulate the process to gain understanding that can be used to build systems for societal needs. The mathematical models are never complete because one does not know what it means to be "complete." Thus mathematical models continuously evolve to include the latest observations and developments in science. In the context of explaining certain observed phenomena which cannot be explained by classical continuum mechanics models, new theories are being postulated (in an attempt to improve existing models). The present lecture is dedicated to an overview of non-local theories/models the author has been working for the last decade. The specific topics to be discussed are Eringen's stress-gradient elasticity [1-4] and Mindlin's couple stress theories [5-8]. These two theories are discussed in the context of reformulating the governing equations of functionally graded material beams and plates and developing associated finite element models.

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Brief Vitae of J.N. Reddy
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Dr. Reddy is a Distinguished Professor, Regents' Professor, and inaugural holder of the *Oscar S. Wyatt Endowed Chair* in Mechanical Engineering at Texas A&M University, College Station, Texas. Dr. Reddy earned a Ph.D. in Engineering Mechanics in 1974 from University of Alabama in Huntsville. He worked as a Post-Doctoral Fellow in Texas Institute for Computational Mechanics (now ICES) at the University of Texas at Austin, Research Scientist for Lockheed Missiles and Space Company, Huntsville, during l974-75, and taught at the University of Oklahoma from 1975 to 1980, Virginia Polytechnic Institute & State University from 1980 to 1992, and at Texas A&M University from 1992.

Dr. Reddy, an ISI highly-cited researcher, is known for his significant contributions to the field of applied mechanics through the authorship of a large number of journal papers and 21 textbooks and the development of shear deformation plate and shell theories and their finite elements. His pioneering works on the development of shear deformation theories (that bear his name in the literature as the *Reddy third-order plate theory* and the *Reddy layerwise theory*) have had a major impact and have led to new research developments and applications. In recent years, Reddy's research has focused on the development of locking-free shell finite elements and nonlocal and non-classical continuum mechanics problems, involving couple stresses, surface stress effects, micropolar cohesive damage, and continuum plasticity of metals.

Dr. Reddy has received numerous honors and awards. Most recent ones include: 2019 Timoshenko Medal from the American Society of Mechanical Engineers, 2018 Theodore von Karman Medal from the Engineering Mechanics Institute of the American Society of Civil Engineers, the 2017 John von Neumann Medal from the U.S. Association of Computational Mechanics, the 2016 Prager Medal, Society of Engineering Science, and 2016 ASME Medal from the American Society of Mechanical Engineers. He is a member US National Academy of Engineering and foreign fellow of Indian National Academy of Engineering, the Canadian Academy of Engineering, and the Brazilian National Academy of Engineering.