VANDERBILT
School *of* Engineering

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Frank L. Parker Distinguished Lecture Series

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FGH 136

"DMCDM: A FUSION OF THE BEST COMPUTATIONAL APPROACHES, FVM & FEM"

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ABSTRACT

There are many computational approaches in use, but the finite volume (FVM) and finite element (FEM) methods have dominated fluid dynamics & heat transfer and solid & structural mechanics, respectively. Each have their own merits and demerits. FVM is based on the global forms of balance laws but lacks a systematic approach to its implementation, largely due to the lack of the interpolation of the field variables. FEM, on the other hand, tends to smooth the solution as it is based on weighted-integral statements of the balance equations. A computational approach as robust (i.e., free from ad hoc numerical knobs and switches) as the FEM and satisfies the global form of balance equations is desirable to solve a variety of problems including coupled (e.g., fluid-structure interaction) problems. The dual-mesh control domain method (DMCDM) developed by the speaker [1] is a hybrid of the FEM and the FVM. DMCDM borrows the physically intuitive idea of satisfying the global form of the governing balance principles—rather than the weighted integral form used in the FEM. From the FEM, it derives the systematic interpolation of geometry and dependent unknowns using finite element interpolation functions. Thus, DMCDM employs two meshes: a finite element mesh (called the primal mesh) for approximating the geometry and unknowns, and another mesh (called the dual mesh) for enforcing the integral form of the balance principles. DMCDM allows for a highly modular implementation, like that of the FEM, where the entire computational process can be decomposed into independent modules. DMCDM has been successfully applied to a wide range of problems—both linear and nonlinear—in solid/structural and fluid mechanics [2-7]. The method offers a viable alternative to established numerical techniques such as the FEM and FVM. It is robust and broadly applicable to boundary value and initial value problems in all of engineering physics. This lecture will present the basic ideas and application of DMCDM to a variety of problems in engineering physics.

BIOGRAPHY

Dr. Reddy is a Distinguished Professor, Regents' Professor, and the holder of the O'Donnell Foundation Chair IV in Mechanical Engineering at Texas A&M University, College Station, Texas. Dr. Reddy, an ISI Highly Cited Researcher, is known for his significant contributions to the field of applied mechanics through the authorship of many textbooks (25) and journal papers (>850). 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.

Dr. Reddy has received numerous honors and awards. Most recent ones include: The Lifetime Achievement Award, from the International Conference on Computational & Experimental Engineering and Sciences, Singapore (2024); 2023 Leonaro da Vinci Award from the European Academy of Sciences, 2023 Michael Païdoussis Medal from the Royal Society of Canada, 2022 IACM Congress (Gauss-Newton) Medal from the International Association of Computational Mechanics, the 2019 SP Timoshenko Medal from American Society of Mechanical Engineers, the 2018 Theodore von Karman Medal from the American Society of Civil Engineers, and the 2017 John von Neumann Medal from the U.S. Association of Computational Mechanics. He is a member ten national academies, including the US National Academy of Engineering, and foreign fellow of Indian National Academy of Engineering, the Canadian Academy of Engineering, the Brazilian National Academy of Engineering, the Chinese Academy of Engineering, the Royal Engineering Academy of Spain, the European Academy of Sciences, the European Academy of Sciences and Arts, the Royal Academy of (Sciences) Canada, and the Portuguese Academy of Engineering.