MME SEMINAR SERIES

Everyone is encouraged to attend!

The Dynamics and Thermodynamics of Gas Dynamic Shock Waves

Joseph Iannelli, PhD, FHEA

Associate Dean
Voiland College of Engineering and Architecture, WSU
Professor, School of Engineering & Applied Sciences, WSU Tri-Cities

Friday, March 1, 2019

12:10 - 1:00 pm | BSEL 102

Abstract

This seminar presents a computational investigation of shock-wave structures through a novel implicit high-order Galerkin finite element Runge–Kutta algorithm. The algorithm induces no spatial discretization artificial diffusion, relies on cubic and higher-degree elements for an accurate resolution of the steep shock gradients, uses an implicit time integration for swift convergence to steady states, and employs original Neumann-type outlet boundary conditions in the form of generalized Rankine Hugoniot conditions on normal stress and balance of heat flux and deviatoric-stress work per unit time. Through an innovative approach, the formulation also calculates the shock extent, which is an additional unknown, and employs the single non dimensional (0, 1) computational domain for the determination of any shock structure. The algorithm rapidly generates steady shock structures, in at most 150 time steps for any upstream Mach number considered in this study, in the range $1.05 < M < 10.0$. The finite element discretization is shown to be asymptotically convergent under progressive grid refinements, in respect of both the H0 and H1 error norms, with an H0 accuracy order as high as 6 and reduction of the discretization error to the round-off-error threshold of 1 x10-9 with just 420 computational cells and 5th-degree elements. For any upstream Mach number, the computational results are shown to satisfy the Rankine–Hugoniot conditions, an established requirement for solution reliability.

Bio

A Fellow of the British Higher Education Academy, Joseph Iannelli is serving as the Associate Dean for International Programs for the entire multi-campus Voiland College for Engineering & Architecture at WSU and as Professor of Mechanical Engineering in the School of Engineering & Applied Sciences at WSU Tri-Cities. Dr. Iannelli's career in higher education spans 25 years, including over a decade of leadership and managerial experience that included the founding of WSU Tri-Cities' School of Engineering and Applied Sciences. An enthusiastic advocate for world-class research and learning in engineering and computer science, he has also established several international education and research partnerships with overseas universities. His areas of research encompass scientific and engineering computing applied to the investigation of non-linear dynamic, fluid dynamic, and thermodynamic systems, including chemically reacting flows about atmospheric reentry vehicles and within gas turbines.

WASHINGTON STATE UNIVERSITY
TRI-CITIES

School of Mechanical and Materials Engineering

Interdisciplinary Excellence Built on World-Class Knowledge