Rarefied & Microscale Gases and Viscoelastic Fluids: a Unified Framework

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Overview

Non-equilibrium flows, such as rarefied flows through micro/nano-channels and around vehicles operating at high altitudes, are now widely studied flows because of their applications in many areas of engineering including MEMS devices. In particular, the flow and heat transfer characteristics of these flows are very interesting. In such systems of microsize, the underlying physics is not yet fully understood, and debate is going on whether the macroscopic laws of physics can simply be scaled down to such scales. Many a times, because of the small length scales associated with these flows, use of the Navier-Stokes equations becomes questionable. The same is true for the flow of viscoelastic fluids even at ordinary length scales. To handle these flows, it is possible to change the governing equations of the flow model from the Navier-Stokes to equations containing higher order terms in the constitutive relationship along with appropriate velocity slip and temperature jump models. Such equations fall under the general category of extended hydrodynamics. At the same time, the Boltzmann equation (kinetic theory) can also be considered for modeling such flows. However, analytical solution of the Boltzmann equation is not possible for most practical flow situations, and hence, numerical solution of the same is typically obtained for flows through such devices using methods such as Direct Simulation Monte-Carlo (DSMC).

The course focusses on developing an understanding/appreciation for the use of higher order continuum equations (extended hydrodynamics)/DSMC for studying flows of rarefied microscale gases and viscoelastic fluids. Through examples and discussions, an attempt will be made to explain the procedures of the advanced subject of non-equilibrium fluid dynamics in a simplistic manner. The course also attempts to touch upon the state-of-the-art research going on at the Gyeongsang National University, South Korea, Indian Institute of Technology Kanpur, India and elsewhere in the world, and the opportunities/challenges that exist in this area. The course, conducted through lectures, case studies and assignments, may also immensely help the participants to identify research areas/develop the research aptitude in general.

Modules	**Rarefied & Microscale Gases and Viscoelastic Fluids: a Unified Framework: Feb 23 - Mar 03** **Number of participants for the course will be limited to hundred.**
You Should Attend If…	▪ Students at all levels (BTech/MSc/MTech/PhD) or faculty from reputed academic institutions and technical institutions. The faculty/students of Mechanical/Aerospace/Chemical Engineering might get especially benefited from the course. ▪ Young/senior engineers and researchers/scientists from government organizations including R&D laboratories, such as VSSC/ISRO, DRDO, NAL, ADA, HAL.
Fees	The participation fees for taking the course is as follows: **Participants from abroad : US $200** **Industry/ Research Organizations: Rs. 6000** **Academic Institutions: Rs. 4000 (for faculty) and Rs. 2000 (for students)** The above fee includes all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hr free internet facility. The participants will be provided with accommodation on payment basis.

The Faculty

Prof. Rho Shin Myong is a Professor of the Department of Aerospace and Software Engineering at the Gyeongsang National University in Jinju, South Korea. He is also the director of Next-Generation Mechanical and Aerospace Creative Engineers Education Program (Brain Korea 21 PLUS National Program) and the chair of the Graduate School of Mechanical and Aerospace Engineering. He is a guest professor of Northwestern Polytechnical University (Xian, China).

He received a Ph.D. degree from the Department of Aerospace Engineering in the University of Michigan in 1996. Prior to the present position, he worked at the NASA Goddard Space Flight Center from 1997 to 1999 as a NRC research associate. In 2014, he was elected to the associate fellow of American Institute of Aeronautics and Astronautics. He is an associate editor of the Communications in Computational Physics (Cambridge) and an editorial board member of the International Journal of Computational Fluid Dynamics (Taylor & Francis). He also serves as a scientific committee member for several international conferences including International Conference on Mathematical Modeling in Physical Sciences. He made fundamental contributions to the theory of rarefied and microscale gases and development of constitutive equation based on the so-called balanced closure, Langmuir slip model, and innovative computational methods. He also made a seminal contribution to theory of shock waves in gases and MHD including intermediate shocks, compound waves, numerical schemes for non-strictly hyperbolic problem applicable to all fields of continuum mechanics associated with rotational symmetry of Newton's law.

Dr. Rakesh K. Mathpal is Assistant Professor in the Department of Aerospace Engineering of the Indian Institute of Technology, Kanpur. He received his Ph.D. from the Pennsylvania State University, US in 2011, and subsequently joined IIT Kanpur in 2012. His research interests include rarefied gas dynamics, hypersonics, molecular dynamics, microfluidics, thermal protection system design and heat transfer analysis.

Course Co-ordinator

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