PIEAS COLLOQUIUM

PAKISTAN INSTITUTE OF ENGINEERING AND APPLIED SCIENCES

Science & Tech. Series

Multiscale Modeling of Heat and Mass Transfer Phenomena in Composite Materials

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PIEAS Lyceum | **1.40 PM, Thu**
26 Dec 2024

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Title of Talk:

Multiscale Modeling of Heat and Mass Transfer Phenomena in Composite Materials

Abstract:

"Multiscale phenomena and processes are prevalent in thermo-fluid engineering and science. Lattice Boltzmann Method (LBM) has attracted significant interest in the CFD community for the solution of multiscale problems. Initially, LBM is developed for various fluid flow problems like developing flow in a channel, flow in a channel having back facing step and flow over multi-obstacles. Then it is adapted for numerical analysis of combined mode viz conduction and radiation heat transfer in absorbing, emitting and scattering medium. After highlighting the advantages of LBM over conventional numerical methods by examining different classes of problems, it is adapted for the calculation of effective thermal conductivity of ceramic fiberboard and aerogel composites.

To promote a better utilization of different numerical methods in different length scales in multiscale modeling, LBM is coupled with FVM (finite volume method) through reconstruction operator as well as flux balance approach. This coupling scheme is applied to simulate various problems such as the fluid flow and reactant transport process in the cathode side of a proton exchange membrane fuel cell (PEMFC), volatile organic compounds (VOC) emissions in airtight as well as in ventilated chambers, natural convection induced by concentration gradient and diffusion-convection-reaction problem.

Finally, due to its simplicity and inherent locality, which support massive parallelism, the performance of LBM has been analyzed using OpenMP for simulating lid driven cavity flows."