VANDERBILT
School of Engineering

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Seminar

Friday,

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12:15 pm

FGH 110

"AVERAGING THEORY APPROACHES TO MODELING IN CIVIL & ENVIRONMENTAL ENGINEERING"

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ABSTRACT

For many physical phenomena, there is a distinction between a smaller scale that is mechanistically well understood, and a larger scale that can be realistically modeled. This distinction of scales, often called the micro- and macroscales respectively, appears regularly in civil and environmental engineering, including when modeling failure of composite materials, groundwater hydrology, and physico-chemical treatment processes, among other examples. By averaging directly from the microscale to the macroscale, accurate models can be developed for many processes which could not be realistically modeled before. Thermodynamically Constrained Averaging Theory (TCAT) is a framework for developing models that uses macroscale equations that have been averaged directly from the microscale, and proposing closure relations that are consistent with the second law of thermodynamics. In this talk, an overview of the TCAT framework is given, with an emphasis placed on the averaging theory framework. Specific application of TCAT to model flow of generalized Newtonian fluids (GNFs) will also be discussed. GNFs have historically been modeled using empirical models that required exhaustive experimental data; however, using TCAT, a model has been developed that only requires a few easily accessible system and fluid parameters. This specific case showcases the potential of TCAT to improve models for a wide range of engineering applications.

BIOGRAPHY

Christopher Bowers completed his dissertation at the University of North Carolina at Chapel Hill in the Spring of 2024 where he applied averaging theory approaches to modeling generalized Newtonian fluids in porous medium systems. He is currently a post-doc at the North Carolina State University where he models UV disinfection of pathogens in air, while continuing his generalized Newtonian fluid work. He has presented at over a dozen conferences, and published four papers in academic journals. Significant works include (1) Generalized Newtonian fluid flow in porous media (https://doi.org/10.1103/PhysRevFluids.6.123302) and (2) Modeling flow of Carreau fluids in porous media (https://doi.org/10.1103/PhysRevE.108.065106). Patent pending for Hyperbolic Reflectance Measuring Device, to accurately determine reflectance of materials at various UV wavelengths.