

Mechanical Engineering Colloquium

Fall 2010 Semester

1pm Wednesday October 20th

Room 224 Mechanical Engineering Center

Dr. Ashwin Vaidya

“Oscillations, Flutter and Autorotation: Experiments and Theory in Fluid-Solid Interaction”

Abstract:

The problem of fluid-solid interaction is one with a broad variety of applications in natural sciences and industry, and has given rise to very interesting and complex questions. In this talk, we focus on the steady and unsteady orientation of a rigid body falling in Newtonian and non-Newtonian liquids. It is well known that a long, rigid body such as a cylinder or a prolate spheroid sedimenting in a Newtonian fluid will orient itself with its major axis perpendicular to the direction of gravity, in its steady state. However, in a viscoelastic fluid, these eventually becomes parallel. Remarkably, in polymer solutions of certain concentrations, the major axis is found to settle at an angle between the horizontal and vertical. We formulate a mathematical theory that attempts to explain these phenomena using different fluid models, Newtonian and non-Newtonian, at low Reynolds and Weissenberg numbers. When the inertial effects of the fluid become very prominent the body can additionally display a variety of interesting behaviors. We shall also discuss our experimental study on the dynamics of a rigid cylinder which is held fixed in place in a recirculating water tank, thus allowing for much longer observation times over sedimentation. The cylinder is suspended in such a way so as allow it to oscillate freely about an axis which is perpendicular to the flow. We study the effect of the Reynolds number (Re) and non-dimensional particle inertia (denoted I^* , which accounts for its length, aspect ratio and density) upon the dynamics which ranges from steady orientation to periodic oscillation and finally, auto-rotation. We will also discuss the effect of vortex shedding at various Reynolds effects upon the body.

Dr. Ashwin Vaidya is Assistant Professor at the Department of Mathematical Sciences at Montclair State University. He arrived at MSU in the fall of 2009. Dr. Vaidya earned his masters in Mathematics and Physics in 1999 and doctorate in 2004 from the Department of Mechanical Engineering at the University of Pittsburgh working with Professor Giovanni Galdi. Between 2004 and 2009, he was a postdoctoral scholar in Applied Mathematics at various institutions including Carnegie Mellon University, Florida State University and the University of North Carolina at Chapel Hill. Dr. Vaidya's area of research lies in theory and experiments in fluid-solid interactions, non-Newtonian fluids and biological fluid mechanics.

For more information, please contact Dr. Ian S. Fischer, 2010 Fall Seminar Coordinator