PURDUE UNIVERSITY

School of Mechanical Engineering

The Hawkins Memorial Lecture
Thursday, October 5, 2006
4:30pm in Room ME 161

BUOYANCY-DRIVEN FLOWS IN NATURAL PHENOMENA AND IN TECHNOLOGY

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An engineering area that has received considerable attention in the recent years is that of buoyancy-induced flows and the associated transport. This growth in research interest has arisen mainly because of increasing concern with the environment, energy and homeland security, as well as the need to develop new materials, advanced transportation systems, alternative energy sources, and efficient systems for energy conversion, storage, utilization and removal. Buoyancy-induced flows are particularly relevant to natural phenomena such as the stratification of lakes, thermosyphons that arise in geothermal systems, recirculations in rivers and oceans, plumes and wakes rising over heat sources, ice melting and solidification, natural convection from the earth surface, and mantle convection in earth's core. These flows in nature are also intimately coupled with pollution resulting from heat and material discharges into the environment. Similarly, buoyancy plays a very important role in enclosure fires such as those in rooms and buildings, as seen in the terrorist attacks on the World Trade Center, and in forest fires. Buoyancy determines the spread of smoke and combustion products in corridors, elevator shafts, airplane cabins, and high-rise buildings. Buoyancy effects arise due to both temperature and concentration differences and can result in strong pressure differences and flows that rapidly spread the fire. Understanding fires at small buoyancy levels in outer space is also important. Similarly, energy storage and extraction processes in solar ponds and in water tanks are strongly determined by buoyancy effects.

Buoyancy-induced flows are also of considerable interest in the development of high quality electronic and optical materials. Buoyancy effects can generate unwanted flows during solidification that can affect local transport rates and redistribute defects and impurities, adversely affecting the quality of the product. This has led to interest in growing pure crystals, for the manufacture of electronic chips, in outer space, where buoyancy effects are essentially nonexistent. Similar considerations arise in thermal sprays, chemical vapor deposition and other materials processing applications. In many cases, external forced flow may be absent or small, making natural convection resulting from buoyancy the only available mechanism for heat removal. This becomes an important safety issue in nuclear reactors and is a major design consideration in electronic systems. The lecture will discuss a wide range of basic and applied processes and also outline future trends in this area in terms of emerging technologies and recent advancements.

Yogesh Jaluria is currently Board of Governors Professor at Rutgers, the State University of New Jersey, New Brunswick, NJ, and the Chairman of the Department of Mechanical and Aerospace Engineering. Professor Jaluria is widely known for his pioneering research in heat transfer, including widely-cited work in buoyancy-driven flows, transport in melting/solidification, continuous processing, stratified environments, room fires, electronic systems, solar ponds, and other applied fields. Professor Jaluria has contributed more than 400 technical articles, including over 160 in archival journals and16 chapters in books and has authored several books. He is the recipient of numerous awards, including the 2003 Robert Henry Thurston Lecture Award from ASME, the 2002 Max Jakob Memorial Award and the 1995 Heat Transfer Memorial Award and was selected as the 2000 Freeman Scholar *for fluid flow phenomena in materials* processing by the Fluids Engineering Division of the ASME. Prof. Jaluria has served as the Chair of the Heat Transfer Division of ASME during 2002-2003. He is presently the Editor of the ASME *Journal of Heat Transfer* and has served as an editor of *Computational Mechanics.*

Refreshments will be served at 4:00pm in Room ME254.

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