ME 4803 Nanoscale Heat Transfer

(3-credit elective, Spring 2016)

Catalog Description: Introduction of micro/nanoscale heat transfer and its applications to energy conversion devices. Description of energy transport at small length and time scales.

Textbook: Z.M. Zhang, *Nano/Microscale Heat Transfer*, McGraw-Hill, New York, 2007. [Selected chapters and sections.]

Prerequisite: ME 3345 or equivalent.

Time&Place: Tu, Th 1:35 – 2:55 PM, **Instr Center 109**

Synopsis: The solutions of more and more technological problems require a solid understanding of the energy transport mechanisms in small length and/or short time scales, especially in applications of micro/nanodevices, microelectronics, microfluidics, molecular and biomedical sensors, laser manufacturing, and advanced energy conversion and storage systems.

This elective course will expose students to the recent developments in thermal analysis at extremely small dimensions and short time scales. The fundamentals of energy transport at small scales will be emphasized. Students will gain an understanding of the microscopic description and approaches in heat carriers and how to calculate the heat transfer when classical equilibrium and continuum approaches break down.

Assessment: About 10 homework assignments, one midterm, and one final exam.

Grading method: 10% class attendance & participation; 40% homework; 20% midterm; 25% final; 5% to proofread graduate student's term paper.

Main topics to be covered:

- Review of macroscopic thermodynamics and heat transfer
- Introduction to microscale phenomena and nanoscience and technology
- Short introduction of statistical mechanics and equilibrium distributions
- Basic kinetic theory and transport properties of ideal gases
- Microfluidics and microscale convection heat transfer
- Properties of solids: specific heat; thermal conductivity of solids; thermal conductivity of thin films (size effect); introduction of thermoelectricity and its applications to cooling and power generation
- Non-Fourier heat conduction: the Boltzmann transport equation (BTE) and nonequilibrium pulsed laser heating
- History of thermal radiation and Planck's law derived from statistical thermodynamics
- Radiative properties of solids, thick films, and thin films