MEEN5900
Special Topics on Nanotechnology: Miro/Nanoscale Energy Transport

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Course Objective:

We are living in a world where scientists and engineers are trying incessantly to reduce the sizes of structures. For micro/nano-scale engineering, fundamental knowledge about microscale energy transport and semiconductor materials is necessary. Micro- and nano-scale devices are requiring interdisciplinary concepts with which physicists, chemists, and electronic and mechanical engineers work together. The objective of this course is to introduce fundamental principles of micro/nano scale energy transport and conversion phenomena. By taking this course, students can be exposed to terminologies regarding various aspects of emerging technologies. Thus, this course will be a building block for establishing an intensive collaboration between different disciplines. The following topics will be covered in this course.

Lecture Hours and Place:
MW 4:00-5:20 pm at NTRP G134

Office hours:
MW 3:00-4:00 pm

Grading:
Homework sets (10%); Midterm exam (30%); Final exam (50%), Term Project (10%)

Course Contents:

Microscopic heat carriers and transport
- Heat carriers
- Kinetic theory
- Mean free path
- Statistical distribution of energy carriers

- Size effect

Material waves
- basic wave characteristics
- wave-particle duality – The Schroedinger equation

Energy states in solids
- crystal structure---lattice description
- lattice vibration and phonons---energy quantization of phonons
- density of states

Statistical description of thermodynamics
- Fermi-dirac, bose-einstein, and boltzmann distribution
- Internal energy and specific heat

Waves
- Electromagnetic waves
- Reflection and refraction at an interface
- Thin film optics
- Evanescent wave and tunneling
- Geometric optics and wave optics

Particle transport process
- Boltzmann equation
- Carrier scattering, phonons, electrons, photons

Semiconductor materials
- band structure

Interfacial phenomena for non-conventional liquids
- Fundamental principles of wetting/dewetting
- Thermofluidic consideration on nanoparticle inks (nanoinks)

Textbook:

Nanoscale Energy Transport and Conversion by Gang Chen, Oxford, 2005

References:

Introductory Quantum Mechanics, 3rd Ed., Richard L. Liboff, Addison-Wesley, 1998.
Introduction to Solid State Physics, 7th Ed., Charles Kittel, John Wiley and Sons, 1996
Microscale Energy Transport, Chang-Lin Tien, A. Majumdar, F. Gerner, 1998
Near-field Nano-optics, M. Ohtsu and H. Hori, 1999.
Optics, E. Hecht, 1998.
Capillarity and Wetting Phenomena, de Gennes et al., Springer 2002