Course: ECE 597EN/697EN Energy Transport and Conversion at the Nanoscale

Instructor: Zlatan Aksamija (zlatana@engin.umass.edu)

Meeting Times: MWF 12:20-1:10 in room 306 ELab

Office Hours: TBD

Description: As electronic, optoelectronic, photonic, and fluidic devices shrink from the microscale down to the nanoscale, the mechanisms for transmitting heat, light, and energy become dramatically different. This course aims to provide a detailed look at thermal, electrical, and optical energy transport and conversion mechanisms at the nanoscale through a parallel treatments of photons, electrons, phonons, and molecules as energy carriers, aiming at fundamental understanding and descriptive tools for energy and heat transport processes from nanoscale continuously to macroscale. Topics include the energy levels, the statistical behavior and internal energy, energy transport in the forms of waves and particles, scattering and heat generation processes, Boltzmann equation and derivation of classical laws, deviation from classical laws at nanoscale and their appropriate descriptions, with applications in nano- and microtechnology. Special topics covering applications of the material taught in the course will include (time permitting) thermoelectric and photovoltaic energy generation and computational methods for nanoscale simulation.


Course Topics:

1. Intro to Nanotechnology and Nanoscale Transport Phenomena
2. Material Waves and Energy Quantization
3. Energy States in Solids
4. Statistical Thermodynamics and Thermal Energy Storage
5. Energy Transfer by Waves
6. Particle Description of Transport Processes
7. Nanoscale Size Effects
8. Energy Conversion and Coupled Transport Processes
9. Special Topics I: Thermoelectric and Photovoltaic energy conversion
10. Special Topics II: Computational Methods for Nanoscale Simulation
Assignments: bi-weekly homework, mid-term and final exam.

Your grade is composed of 4 parts: homework, reading assignments/quizzes, midterm exam and final project

- 6 homeworks assigned on a bi-weekly schedule
- Homework collected each time next homework is assigned, but ultimately due at the exam practice class and last day of class
- Best 5 homework scores count 25% of the grade
- 6 bi-weekly reading assignments mainly consisting of review papers from the literature (typically Reviews of Modern Physics) followed by discussion and short quiz
- 5 reading quiz scores count 15% of the grade
- Mid-term exam counts 25%

Suggested Readings:


Final Project:

- Project will be computational in nature
- Develop a Matlab/C/C++/Python code to simulate a physical process or implement a calculation based on a reading assignment
- Project done in teams of 2, however:
  - Undergraduate and Graduate students teamed up and graded separately
  - Undergraduate students present as teams and submit one report
Graduate students give conference-level talks individually and present a collaborative paper following guidelines and formatting for a research journal. All presentations are 15 min plus 5 min for questions.

- Project can be selected to enhance your own research project.
- Final presentation is worth 10% and project report is 25% of the grade.
- Presentation grade will be based on class feedback.