Spring 2023

MTSE 724 - 002: Transport of Electrons, Phonons and Photons

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New Jersey Institute of Technology, Department of Physics
MTSE 724-102 (CRN 14948), Spring 2023
TRANSPORT OF ELECTRONS, PHONONS, AND PHOTONS
Mondays, 6:00 pm to 8:50 pm, FMH 203

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Textbooks:

- Gang Chen, **Nanoscale Energy Transport and Conversion**, Oxford University Press, 2005, ISBN-13: 978-0195159424.
- Charles Kittle, **Introduction do Solid State Physics**, (eighth edition) Wiley, (2004), ISBN-13 : 978-0471415268

Learning Outcomes: This course provides a microscopic description of energy transport and energy conversion processes in solids. Students will learn about the behavior different energy carriers: electrons, phonons, photons. Energy transport both as waves and as particles will be considered in detail, due to the quantum nature of the carriers. The effect of small size structures on transport will be considered. Students will apply this knowledge to the study of Thermoelectric systems, Semiconductors, and Photovoltaic devices.

Homework: Homework assignments will be posted online on Canvas and they will be due before the beginning of the lecture (that is, Monday). You may solve the problems, scan your work, and upload it as a pdf file.

Projects: After the midterm exam we will identify subjects relevant to the course and you will prepare a report on one of this topics. Details will follow.

Exams: There will be two exams, covering each half of the course material. There will be a combination of multiple choice and problem solving. The first exam will take place on Monday, 03/06. The second one will, most likely, take place on Monday, 05/08.

Date:	**Subject** (book chapter from Chen):
01/23	Introduction, (Ch. 1)
01/30	Material Waves and Energy Quantization (Ch. 2)
02/06	Electronic Energy States in Crystals (Ch. 3)
02/13	Phonon Energy Levels in Crystals (Ch. 3)
02/20	Statistical Thermodynamics (Ch. 4)
02/27	Energy Transfer by Waves (Ch. 5)
03/06	*Midterm Exam (First Half of the Course)*
03/13	*Spring Break*
03/20	Wave Phenomena and Landauer Formalism (Ch. 5)
03/27	Particle Description, Liouville and Boltzman Equations (Ch. 6)
04/03	Electron Transport and Thermoelectric effects (Ch. 6)
04/10	Classical Size Effects (Ch. 7)
04/17	Coupled Transport Processes, Semiconductors, Photovoltaics (Ch. 8)
04/24	Forces and Potentials Between Particles and Surfaces (Ch. 9)
05/01	Special Topics
05/08	*Final Exam (Second half of the Course)*

Final Grade: Midterm Exam: 25%; Final Exam: 25%; Homework: 25%; Project: 25

Grade Scale: A: 85% and more; B+: 75% - 84%; B: 65% - 74%;
C: 50% - 64%; D: 40% - 49%; F: 39% and less