Fall 2024

MTSE 724 - 101: Transport of Electrons, Phonons and Photons

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New Jersey Institute of Technology, Department of Physics MTSE 724-101
(CRN 94949), Fall 2024

TRANSPORT OF ELECTRONS, PHONONS, AND PHOTONS

Mondays, 6:00 pm to 8:50 pm, FMH 205

Instructor: Dr. Andrés Jerez, Tiernan Hall 455 **email:**
jerez@njit.edu
(When writing, please include course and section in the subject:
MTSE 724 101)

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 these 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.

Academic Integrity: Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: NJIT Academic Integrity Code.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.

Generative AI: This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this content area. As such, AI usage is not permitted throughout this course under any circumstance.

Date:	**Subject** (book chapter from Chen):
09/09	Introduction, (Ch. 1)
09/16	Material Waves and Energy Quantization (Ch. 2)
09/23	Electronic Energy States in Crystals (Ch. 3)
09/30	Phonon Energy Levels in Crystals (Ch. 3)
10/07	Statistical Thermodynamics (Ch. 4)
10/14	Energy Transfer by Waves (Ch. 5)
10/21	*Midterm Exam (First Half of the Course)*
10/28	Wave Phenomena and Landauer Formalism (Ch. 5)
11/04	Particle Description, Liouville and Boltzman Equations (Ch. 6)
11/11	Electron Transport and Thermoelectric effects (Ch. 6)
11/18	Classical Size Effects (Ch. 7)
11/25	Coupled Transport Processes, Semiconductors, Photovoltaics (Ch. 8)
12/02	Forces and Potentials Between Particles and Surfaces (Ch. 9)
12/09	Special Topics
12/16	*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