Physics 7450
Solid-State Transport
Fall 2019

OVERVIEW

This is an advanced graduate level course on the transport of charge and heat by electrons and phonons in metals.

Lectures: MWF 3:00-3:50 PM, Hale Science 240.

Instructor: Andrew Lucas (`andrew.j.lucas@colorado.edu`); Duane F629.
For office hours, feel free to drop by or (preferably) e-mail first to set up an appointment.

Website: https://sites.google.com/colorado.edu/andrew-lucas/teaching/physics-7450-fall-2019

Books: There are no required textbooks for the course.

Recommended Prerequisites: Physics 7440 (or similar).

COURSE MATERIAL

1: Drude model. Introduction to the thermoelectric conductivity matrix.

2: Kinetic theory of transport. Quantum Boltzmann equation. Scattering rates of electrons and phonons. Wiedemann-Franz and Mott laws, and their violations.

3: Hydrodynamics. Derivation from kinetic theory. Plasmons. Momentum relaxation.

4: The ballistic-to-hydrodynamic crossover. Zero-to-first sound crossover. Gurzhi effect.

5: Classical magnetotransport. Hall effect. Absence of classical magnetoresistance. Hall viscosity

6: Linear response theory. Formal definition of transport coefficients. Fluctuation-dissipation theorem

7: Hydrodynamic correlation functions. Kadanoff-Martin formalism. Hydrodynamic poles.

8: Memory matrix formalism. Almost conserved quantities. Transport in weakly inhomogeneous media. Hydrodynamics from the memory matrix.

GRADES

▶ **100% homework:** Homework is **due at or before the beginning of class**, approximately every other Friday. **Late homework is not accepted**, so that solutions may be posted in a timely manner. Your grade will be the average of your homework scores, except that your **2 lowest scores will be dropped**. This policy is meant to remove any stress associated with conflicting religious holidays, personal or professional events, and/or short-term illness. You are welcome to – without explanation – not turn in a homework assignment should you wish for it to be dropped. You can work together on homework problems, but you must write up your own solutions.