Advanced Topics in Theory: Wave Propagation in Random Media

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I plan to cover the following subjects:
1) Transfer Matrix formalism
   • Scattering Matrix and Transfer Matrix
   • Transmission and Reflection Amplitudes
   • Properties of Transfer Matrix

2) Rectangular Potentials
   • Transfer Matrix
   • Transmission Coefficient: $E>V_0$
   • Tunneling: $0<E<V_0$
   • Current Density
   • Bound States: $V_0<E<0$
   • Inverse Problem for Rectangular Potential

3) Delta-function potential
   • Single delta-function Potential
   • Two delta-function Repulsive potentials
   • Bound states of Double \delta-function Attractive Potentials
   • N indentical \delta-function Barriers

4) Kronig-Penney Model
   • The periodic model
   • Allowed Energy Bands
   • The density of States
   • Wave function
   • Single Impurity
   • N \delta-function Barriers versus Infinite Kronig-Penney Model
5) Tight-Binding Model
   • Periodic Model
   • The Transfer Matrix
   • Transmission Coefficient
   • Single Impurity
   • Transmission through Impurities
   • Coupled pendulum Analogy of the tight-binding model

6) Tight Binding Models of Crystals
   • Periodic one-dimensional system with two different atoms
   • Periodic model with different distances between neighboring atoms
   • Periodic one-dimensional system with two different atoms and spatial period $l=4a$
   • Reduced zone scheme

7) Disordered Models
   • Random tight-binding model
   • Random Kronig-Penney model
   • Anderson localization and localization length: Weak disorder expansion
   • Thouless relation

10) Mesoscopic Conductance
    • Transmission matrices and Conductance
    • Conductance of a periodic sample
    • Conductance of a disorder sample

Bibliography
1) Wave Propagation: From electrons to Photonic Crystals and Left-Handed Materials
   P. Markos and C. M. Soukoulis
2) “Notes on Transfer Matrix Theory and Anderson
Localization”, T. Kottos.

Exams
1) There are going to be weekly exercises that you have to deliver on Fridays at 12:00 noon. (60%)
2) There will be one final test according to registrar’s schedule (40%)

The maximum grade is 100%. During the exams you can have 1 page (A4) of notes where you can write down formulas but NOT derivations neither solution of exercises.