

Exercise #06 (Fully optional)

These exercises are optional. You can solve **one** of the points below at your convenience and discuss it at the oral examination. This will be the subject of one of the three questions of the oral examination.

a) Ising model in infinite and one dimensions.

Prove that the exact solution of the infinitely connected Ising model is given by the mean field theory. Following the lines in this notes evaluate the partition function using the steepest descent method.

After reading chapter II of [R.J. Baxter - Exactly solved models in statistical mechanics-Academic Press (1982)].

- Solve the Ising one-dimensional model with the transfer matrix method and prove that there is no phase transition at non zero temperature. Evaluate the entropy and the specific heat.
- Discuss the zero temperature limit.

b) A particle in an oscillator's bath.

Following the instruction here below

<http://www.aquila.infn.it/ciuchi/didattica/DOTT/OpenSystems/index.html>

try to compile and run the program Oscillators (a fortran compiler is needed).

Once compiled successfully try exercises #1 #2 #3.

c) BCS superconductivity.

Derive the Landau theory for the superconducting transition after watching the following recorded lecture:

- Video

You can also follow a set of notes:

- The BCS model
- A resume of the solution of BCS model by mean-field approach.
- Technical details of Bogoliubov transformation
- Detailed solution of BCS model by mean-field approach.

For reading you can see the book of Linda E. Reichl "A Modern Course in Statistical Physics" chapt. 4 and chapt. 6.11

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