In this project we considered two methods for qualitatively and quantitively analyzing a system. These methods were The Mean Field Approximation Method and the Monte-Carlo Simulation Method. For our case, we considered the interaction of the spins of many atoms in the system, where the spins could only take two states – up and down. The goal of the analysis was to calculate the average spin alignment of the atoms in the material. We derived the Energy function for the system of N particles describing the total energy influenced by the alignment of the spin of each particle:

$$E = -J \sum_{\langle ij \rangle} s_i s_j - \mu H \sum_i s_i$$

Where H is the magnetic field and μ is the magnetic field moment associated with each particle.

The first method of analyzing the statistics of a large system consisting of many connected particles that we studied in this project is the Mean Field Approximation. The Mean Field Approximation replaces the interaction between each of the terms by a general effective field, takes as an average of the interactions from each of the particles. Therefore, replacing the term for magnetic field moment by the mean magnetic field created from the average spin of the particles in the system:

$$H_{\text{eff}} = \frac{J}{\mu} \sum \langle s \rangle = \frac{z\,J}{\mu} \langle s \rangle$$

This approximation of the solution let's us obtain a transcendental equation that we then solve numerically and obtain Graph 1.

In the Graph1 we see that as the temperature increases, we expect the average of the spins to fall to zero due to the increased disorder and thermal fluctuations, therefore, our model shows this falloff of the mean magnetization.