

### **Question bank for the Stat Mech for Mat exam**

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| 1. Microstates, macrostates, thermodynamic averages and the density of states               | 1 1 |
| 2. Equiprobability and the Boltzmann definition of entropy                                  | 1 2 |
| 3. Statistical mechanics of adatoms on a surface. Non-additive entropy at the nanoscale     | 1 3 |
| 4. The canonical partition function from a system-bath description                          | 1 4 |
| 5. Statistical mechanics of a paramagnetic material   | 1 5 |
| 6. Information entropy and the Gibbs definition of entropy                                  | 1 6 |
| 7. The definition of ensembles using constrained maximization of entropy                    | 2 1 |
| 8. The link between statistical mechanics and thermodynamic potentials                      | 2 2 |
| 9. The grand canonical ensemble. Sketch of the derivation and meaning                       | 2 3 |
| 10. Density fluctuations and the ideal gas law  | 2 4 |
| 11. Langmuir adsorption isotherm from a statistical mechanical perspective                  | 2 5 |
| 12. Non-interacting systems. Partition function and thermodynamic properties                | 2 6 |
| 13. Indistinguishable particles: definition of microstates and symmetry of the wavefunction | 3 1 |
| 14. Bose and/or Fermi statistics from a grand-canonical formalism                           | 3 2 |
| 15. Vibrations in solids: classical and quantum statistics                                  | 3 3 |
| 16. Heat capacity in solids and low-dimensional materials                                   | 3 4 |
| 17. A density-functional theory of the free electron gas (NO Sommerfeld expansion)          | 3 5 |
| 18. The Ising model in 1D, exact treatment.   | 3 6 |
| 19. The Ising model in 2D, mean field treatment.  | 4 1 |
| 20. Response properties of the mean-field Ising model                                       | 4 2 |
| 21. Universality. Mapping on the Ising model, critical exponents                            | 4 3 |
| 22. Statistical mechanical description of liquids. The pair correlation functions           | 4 4 |
| 23. The reversible work theorem   | 4 5 |
| 24. Pair potentials and the properties of liquids   | 4 6 |
| 25. Statistical description of polymer chains   | 5 1 |
| 26. Entropy-driven elasticity of a freely-joint polymer                                     | 5 2 |

#### **Rules:**

- The exam contributes 60% to the final mark, 40% coming from the evaluation of lab report that have already been graded during the year
- The question bank is made available to all students at the end of the course
- The candidate throws two dice to select a question. They have the right to throw again once, but cannot return on the first question if they dislike the second one even more.