<table>
<thead>
<tr>
<th>Course Title</th>
<th>STATISTICAL PHYSICS</th>
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</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>PHY 342</td>
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<tr>
<td>Course Type</td>
<td>Compulsory</td>
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<tr>
<td>Level</td>
<td>Advanced</td>
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<tr>
<td>Year / Semester</td>
<td>3rd year / 5th semester</td>
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<tr>
<td>Teacher’s Name</td>
<td>Georgios Archontis</td>
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<tr>
<td>ECTS</td>
<td>6</td>
</tr>
<tr>
<td>Lectures / week</td>
<td>3 (1.5 +1.5 + 1 hours)</td>
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<tr>
<td>Laboratories / week</td>
<td>1 (1 hour tutorial)</td>
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<tr>
<td>Course Purpose and Objectives</td>
<td>Basic introduction to Statistical Mechanics.</td>
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**Learning Outcomes**

- Know the statistical mechanical definition of entropy.
- Calculate the microcanonical entropy of various systems (system with two energy states, quantum harmonic oscillator, quantum and classical ideal gas, rotational partition function).
- Derive the microstate probability in the canonical and grand-canonical ensembles.
- Compute the canonical and grand-canonical partition functions and use them to obtain thermodynamic quantities of interest.
- Derive the mean occupation number in for MB, FD and BE statistics.
- Compute the heat capacity of solids (Einstein and Debye model).
- Derive the thermodynamic potentials for the photon gas.
- Apply FD statistics to study the properties of Fermi gases in the context of the free electron gas and white dwarfs.
- Apply BE statistics to study the properties of the ideal boson gas.
- Solve the Ising model in one dimension.

**Prerequisites**

- PHY 210 (Thermal Physics)

**Course Content**

The concept of phase space. The statistical mechanical definition of entropy. Microcanonical ensemble and examples (two-level system, classical and quantum ideal gas, classical and quantum harmonic oscillator). Canonical ensemble (derivation of the Boltzmann factor, relation between partition function and thermodynamic quantities, classical ideal gas, classical harmonic oscillator, the equipartition theorem, paramagnetism, rotational partition function. The grand-canonical ensemble. Derivation of the mean occupation number in Bose-Einstein, Fermi-Dirac statistics. The
quantum ideal gas. Applications of Fermi-Dirac and Bose-Einstein statistics (Einstein and Debye models for the heat capacity of solids, the photon gas, free electrons in metals, white dwarves, Bose-Einstein condensation.) Ising model in one dimension.

### Teaching Methodology
There are four lecture hours / week. A typical lecture starts by a short discussion and review of previously covered material. Students are engaged in the discussions via suitable questions.

The lectures utilize the blackboard. In the recitation hour we discuss problems and applications, go over the solutions of assignments and answer student questions.

The students are given ~6 home assignments that they have to complete in a course of 7-10 days each. Student collaboration is permitted, but the preparation of individual reports is very strongly encouraged.

### Bibliography
1. Stephen Blundell and Katherine M. Blundell. Έννοιες Θερμικής Φυσικής (Πανεπιστημιακές Εκδόσεις Κρήτης).
2. Mandl. Στατιστική Φυσική (Ελληνική μετάφραση).
5. Ι. Βέργαδος και Η.Σ. Τριανταφυλλόπουλος. Στατιστική Φυσική (Ελληνικό κείμενο).

### Assessment
- Home assignments (20%)
- One midterm exam (40%)
- Final exam (40%)

### Language
Greek. Part of the bibliography is in English.