Name: Condensed matter physics - 34066

Type: Elective **Semester:** 1st

ECTS: 5

Periodicity: annual

Departments involved: Department of Fundamental Physics (UB)
Department of Physics and Nuclear Engineering (UPC)

Coordinator: M. del Carmen Miguel Lopez

Professors: Elvira Guardia Manuel, Ferran Mazzanti Castrillejo, M. del Carmen Miguel Lopez

Language: Catalan / Spanish / English

Prerequisite: Basic knowledge of Statistical Physics

Aims:

We aim to present the students an overview of the physics of condensed matter systems.

Particular attention is given to phase transitions and to the physical properties of classical, complex and quantum liquids. The properties solid state and magnetic systems are also considered and described.

Syllabus:

1. INTRODUCTION
1.1 Interactions and energy scales.
1.2 Condensed phases of matter: structure and symmetries.
1.3 Examples: liquids and gases, liquid crystals, crystalline solids, quasicrystals, glasses, complex fluids, etc.

2. STATISTICAL MECHANICS (MODELS)
2.1 Symmetry and order parameters.
2.2 Discrete and continuous models.
2.3 Symmetry breaking.
2.4 Universality.

3. PHASE TRANSITIONS
3.1 Mean-field theories.
3.2 Landau theory.
3.3 Introduction to the Renormalization Group.
3.4 Aplications to solid-state systems.

4. CORRELATION FUNCTIONS AND ESPECTROSCOPY
4.1 Distribution, correlation and response functions.
4.2 Linear response theory.
4.3 Aplications to simple liquids.

5. SOFT CONDENSED MATTER
5.1 Molecular liquids.
5.2 Polimers.
5.3 Complex fluids.

6. QUANTUM LIQUIDS
6.1 Bose-Einstein condensation.

6.2 Superfluidity.
6.3 Variational description.

Methodology:

Every week there will be theoretical and practical lectures, approximately 3+1 h., respectively.

Students will be responsible of preparing certain parts of the course, previously assigned by the course professors, and presenting them during the class hours. They will also actively participate in the practical lectures by solving the course problem sets either individually or in working groups during the class hours.

Evaluation:

The final grades will be determined from:

- Written exam: 50% of the course grade will come from the score of this final exam about the contents exposed through the theoretical and practical course lectures.
- Homework: the other 50% will be obtained from homework assigments to be handed to the course professors during the semester.

Bibliography:

Chaikin, P.M.; Lubensky, T.C. *Principles of Condensed Matter Physics.* Cambridge University Press, 2003.

Pathria, R.K. Statistical Mechanics. Butterworth-Heinemann, Oxford, 1996.

Goldenfeld, N. *Lectures of Phase Transitions and the Renormalization Group.* Addison Wesley, Reading, 1992.

Plischke, M.; Bergersen, B. *Equilibrium Statistical Physics.* World Scientific, Singapore, 1994.

Binney, M.J.J.; Dowrick, N.J.; Fisher, A.J.; Newman, M.E.J. *The Theory of Critical Phenomena.* Oxford Univ. Press, 1993.

Cardy, J. *Scaling and renormalization in Statistical Physics.* Cambridge Univ Press, 1996.

Chandler, D. *Introduction to Modern Statistical Mechanics.* Oxford University Press, 1987.

Hansen, J.P.; McDonald, I.R. *Theory of Simple Liquids.* Academic Press, 1986.

Jones, R.A.L. Soft Condensed Matter. Oxford University Press, 2006.

Masao Doi *Introduction to Polymer Physics.* Clarendon Press, 1996.

Larson, R.G. *The structure and theology of complex fluids.* Oxford Univ Press, 1999.

Prosperi, D.; Rosati, S.; Violini, G. *First International Course on Codensed Matter.* World Scientific, 1988.