Course guide
230859 - FAM - Atomic and Molecular Physics

Last modified: 03/06/2022

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Optional subject).

Academic year: 2022 **ECTS Credits:** 4.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Electromagnetism, Mechanics, Probability and Statistics, Basics of Quantum Physics

REQUIREMENTS

Mechanics, Probability and Statistics, Thermodynamics, Quantum Physics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Basic:
CB6. (ENG) Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación
CB7. (ENG) Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB9. (ENG) Que los estudiantes sepan comunicar sus conclusiones ¿y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades
CB10. (ENG) Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

TEACHING METHODOLOGY

There will be three hours per week of lectures, addressing both theory and practical exercises.

LEARNING OBJECTIVES OF THE SUBJECT

- Know how to describe atoms, and how those can be treated quantum mechanically
- Understand the behavior of atoms in electromagnetic fields
- Explain the appearance of the fine and hyperfine structures
- Understand how the symmetries of the wave function and of the orbitals lead to the periodic table of the elements
- Fundamentals of molecular physics
- Approach to recent discoveries and state-of-the-art experimental techniques

STUDY LOAD

Type	Hours	Percentage
Self study	64,0	64.00
Hours large group	36,0	36.00

Total learning time: 100 h

CONTENTS

Topics

Description:
• Introduction: the hydrogen atom
• Interaction between atoms and external fields (static, and oscillating)
• Fine and hyperfine structure
• Selection rules
• Symmetries of the wave function
• Atoms with many electrons (Thomas Fermi model, and Hartree-Fock method)
• Understanding the periodic table of the elements
• Molecular structure and degrees of freedom
• Spectroscopy techniques
• Laser cooling and preparation of ultra-cold quantum gases of bosons and fermions

Specific objectives:
Doesn't apply.

Related activities:
Upon request it will be possible to visit experimental atomic physics research labs at the Institute of Photonic Sciences (ICFO, in Castelldefels).

Full-or-part-time: 100h
Theory classes: 28h
Practical classes: 4h
Guided activities: 20h
Self study : 48h

GRADING SYSTEM

The final score will result from the weighted average of two marks:
E1 (70%): homeworks assigned on a regular basis.
E2 (30%): written report, oral presentation and defense of a personal project.

There will be no re-evaluation.

EXAMINATION RULES.

Doesn't apply.

BIBLIOGRAPHY

Basic:
- Pethick, Christopher; Smith, Henrik. Bose-Einstein condensation in dilute gases . 2nd ed. Cambridge ; New York : Cambridge University Press, 2008. ISBN 052184651X.
- Foot, C. J. Atomic physics. Oxford: OUP, 2005. ISBN 0198506953.
- Demtröder, W. Atoms, molecules and photons: an introduction to atomic-, molecular- and quantum physics. 3rd ed. Springer, 2018. ISBN 9783662555217.
- Bransden, B.H.; Joachain, C.J. Physics of atoms and molecules. 2nd ed. Upper Saddle River, N.J.: Prentice Hall, 2002. ISBN 058235692X.

RESOURCES

Other resources:
Electronic format texts:
1)
https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Book%3A_An_Introduction_to_the_Electronic_Structure_of_Atoms_and_Molecules_(Bader)
2)
https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Time_Dependent_Quantum_Mechanics_and_Spectroscopy_(Tokmakoff)