Course guide
230859 - FAM - Atomic and Molecular Physics

Last modified: 19/06/2024

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: 2024 **ECTS Credits:** 4.0 **Languages:** English

LECTURER

Coordinating lecturer: PIETRO ALBERTO MASSIGNAN

Others: Primer quadrimestre:
PIETRO ALBERTO MASSIGNAN - 10
ROSENDO REY ORIOL - 10

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. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study.
CB9. Students should know how to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

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: 36h
Self study : 64h

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

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)