COURSE DATA

Data Subject	
Code	44005
Name	Lasers
Cycle	Master's degree
ECTS Credits	5.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2184 - M.U. en Química Teórica y Modelización Computacional 13-V.1	Faculty of Chemistry	1	First term

Subject-matter

Degree	Subject-matter	Character
2184 - M.U. en Química Teórica y Modelización Computacional 13-V.1	5 - Optional subject area	Optional

Coordination

Name	Department
SANCHEZ MARIN, JOSE	315 - Physical Chemistry
TUÑON GARCIA DE VICUÑA, IGNACIO NILO	315 - Physical Chemistry

SUMMARY

English version is not available

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

2184 - M.U. en Química Teórica y Modelización Computacional 13-V.1

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Students are able to foster, in academic and professional contexts, technological and scientific progress within a society based on knowledge and respect for: a) fundamental rights and equal opportunities between men and women, b) The principles of equal opportunities and universal accessibility for persons with disabilities, and c) the values of a culture of peace and democratic values.
- Skills in analysis and synthesis.
- Students demonstrate their knowledge and understanding of the facts applying concepts, principles and theories related to the Theoretical Chemistry and Computational Modeling.
- El estudiante tiene capacidad de generar nuevas ideas.

LEARNING OUTCOMES

Understand the fundamentals of laser light and its main applications in quantum chemistry and atomic and molecular physics. Get familiar with the resolution of time-dependent problems and dealing with states in the continuum.

DESCRIPTION OF CONTENTS

1. Topics and sub-topics

1. Introduction. What is a laser? What are lasers used for? Characteristics of laser light.
2. Laser properties. Energy levels. Formation of spectral lines: Einstein's coefficients. Spontaneous and stimulated emission. Population inversion and saturation. Widening of spectral lines. Practical examples of lasers.
3. Continuous wave lasers (cw) and pulsed lasers. Generation of cw lasers. Bandwidth reduction.

Formation of laser pulses by Q-switching and modelocking.
4. Laser-matter interaction. Classical and quantum description. Multiphoton processes and tunneling. Three-step model. High-order Harmonic Generation (HOHG). Attosecond lasers pulses and pulse trains.
5. Strong field effects. Rabi frequencies. Stark shifts. Above-threshold ionization (ATI). Dressed states. Floquet and Volkov states. Strong-field approximation.
6. Theoretical approaches. Basis of states in the electronic continuum: B-splines. Direct integration of the time-dependent Schrödinger equation. Hybrid methods.
7. Time-resolved spectroscopy. Pump-probe schemes with laser pulses. Uses in femtochemistry and attophysics. Attochemistry.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	34,00	100
Seminars	10,00	100
Tutorials	6,00	100
Development of individual work	20,00	0
Study and independent work	35,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

Lecture: The Professor will deliver lectures about the theoretical contents of the course during two-hour sessions. The presentations will be based on the different materials available at the Moodle platform.

Network teaching: All the tools available at the Moodle website (http://www.uam.es/moodle) will be used (uploading of teaching materials, utilization of work team strategies, wiki, blogs, e-mail, etc.).

Tutoring sessions: The professor can organize either individual or group tutoring sessions about particular topics and questions raised by students.

EVALUATION

Ordinary assessment

The knowledge acquired by the student will be evaluated along the course. The educational model to follow will emphasize a continuous effort and advance in training and learning.

The final student mark will be based on exercises that must be done during the course. The next criteria will be followed for assessment of student exercises:

- 70% Exam at the end of the course.
- 30% from the student report.

Extraordinary assessment

The student will have to face a final exam, including both theory and practical exercises. The student mark will be obtained from:

- 70% from the final exam,
- 30% from the individual work.

REFERENCES

Basic

- 1. Introduction to Laser Technology. B. Hitz, J. J. Swing and J. Hecht. IEEE Press, New York, 2001.
2. Introduction to Quantum Optics. G. Grynberg, A. Aspect and C. Fabre. Cambridge University Press. Cambridge, 2010.
3. Principles of Lasers. O. Svelto. Plenum Press, New York. 1998.
4. Laser Fundamentals. W. T. Silfvast. Cambridge University Press, Cambridge, 2004.
5. Quantum Optics. M. O. Scully. Cambridge University Press. Cambridge, 1997.
6. Lasers. A. E. Siegman. University Science Books. 1986.
7. Bachau H, Cormier E, Decleva P, Hansen J E and Martín F 2001 Rep. Prog. Phys. 64 1815.
8. Martín F 1999 J. Phys. B (Topical Review) 32 R197