uc3m | Universidad Carlos III de Madrid

Modern Physics

Academic Year: (2023 / 2024) **Review date: 29-03-2023**

Department assigned to the subject: Physics Department

Coordinating teacher: MARTIN SOLIS, JOSE RAMON

Type: Electives ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Courses on Mathematics and Physics of the bachelor previous to this course

SKILLS AND LEARNING OUTCOMES

LEARNING OUTCOMES:

- Understand the fundamentals of the most important theories of modern physics such as the theory of relativity or quantum mechanics.
- Understand and become familiar with the use of the mathematical language of modern physics.
- Understand the meaning of the probabilistic description of quantum mechanics and its relationship with the macroscopic world.
- Understand the implications of the concept of quantum measurement.
- Understand the notion of quantum entanglement.
- Understand the basic structure of atoms.
- Be able to solve the Schrödinger equation for some simple cases.
- Understand the meaning of spatial and temporal dilations and contractions predicted by the special theory of relativity.
- Understand the meaning and handle with ease the concepts of momentum and energy in the theory of special relativity.

OBJECTIVES

OBJECTIVES:

The Course on Modern Physics aims to provide an introduction to the basic pillars on which Modern Physics is based: the theories of relativity - special and general ¿ and the quantum mechanics. The former transformed our ideas about space, time and the universe. On the other hand, the quantum revolution changed our image of the atomic and subatomic world and, ultimately, of the intimate structure of matter. Some of the main scientific and technological consequences that derive from them, and that have contributed to transform our world, such as the atomic energy, lasers, semiconductor devices and computers, superconductivity, etc, will be also discussed.

DESCRIPTION OF CONTENTS: PROGRAMME

PART I THEORY OF RELATIVITY

1 Postulates of the Special Theory of Relativity
  1.1 Introduction
  1.2 The Classical Relativity
    1.2.1 The Galilean Principle of Relativity
    1.2.2 The Galilean Transformation and Classical Mechanics
  1.3 The Principle of Relativity and the Electromagnetic Theory
  1.4 Einstein¿s Postulates
2 Relativistic Kinematics
  2.1 Lorentz Transformation
    2.1.1 Lorentz Transformation of Coordinates
    2.1.2 Lorentz Velocity Transformation
  2.3 Consequences of the Lorentz Transformation
    2.3.1 Time Dilation
    2.3.2 Contraction of Length
    2.3.3 Relativity of Simultaneity
3 Relativistic Dynamics

LEARNING ACTIVITIES AND METHODOLOGY

* Lectures where the theoretical concepts are explained

The lecturer will provide the following information (1 week in advance)
- Main topics to be discussed during the session
- Chapters/sections in each of the text books provided in the bibliography where the student can read about these topics

* Activities for the solution of problems

The main skills to be acquired in these activities are:
- To understand the statement of a problem (for instance drawing an scheme that summarizes the statement)
- To identify the physical phenomenon and the physical laws involved in the problem
- To develop an strategy to reach the objective (for instance breaking the problem in small subproblems)
- To be careful in the use of mathematics
- To be able to make a critical analysis of the results (is the final number sensible?, are the dimensions consistent?)

* Small tasks focused to search for scientific information from different sources (mainly internet)

* Laboratoy sessions (~ 20 - 30 students divided in 2 people groups)

The main skills to be developed in this activity are:
- To understand that physics is an experimental science and that they can verify the laws that have been theoretically explained in the lectures
- To use scientific instruments and to be careful in its operation
- To be careful in the acquisiton of experimental data.
- To learn the basis for the management of a scientific data set
- To be able to write a report with the main results of the experiment
- To be able to discuss in a critical way the experimental results: have we achieved the goals of the experiment?

* Hours for individual tutorials will be set through Aula Global. It is possible to schedule sessions at other times by appointment with the lecturer

ASSESSMENT SYSTEM

* Laboratory sessions (15% of final mark)

Attendance to the laboratory sessions is compulsory. The students must also write a report on each of the experiments carried out in every session. The mark will be common for all the members of each group.

* Activities in the group (25% of final mark)

The evaluation will take into account attendance and student attitude, short exams periodically proposed, as well as the student performance in the proposed activities.

* Written exam (60% of final mark)

The exam will take place at the end of the semester and it will be common for all the students. Contents:

- Problems to be solved covering the main topics of the program
- Short theoretical questions.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- P.A. Tipler, G. Mosca PHYSICS for Scientists and Engineers, W.H. Freeman, 2007
- R.A.. Serway, J.W. Jewett PHYSICS for Scientists and Engineers, Brooks/Cole, 2012

ADDITIONAL BIBLIOGRAPHY

- A.P. French SPECIAL RELATIVITY, The M.I.T. Introductory Physics Series, CRC Press, 2017
- M. Alonso, E.J. Finn PHYSICS, Addison-Wesley, 1992
- R. Eisberg, R.Resnick QUANTUM PHYSICS, John Wiley & Sons, 1985