COURSE GUIDE

Mechanics and Waves (2671122)

Approval date: 19/06/2023

Grado (Bachelor's Degree)	Grado en Física	Branch	Sciences
Module	Mecánica y Ondas	Subject	Mecánica y Ondas

Year of study	2º	Semester	1 y 2º	ECTS Credits	12	Course type	Compulsory course

PREREQUISITES AND RECOMMENDATIONS

It is recommended to have completed the subjects of Physics, Linear Algebra and Geometry, and Mathematics of the first academic year.

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

- Newtonian Mechanics: Conservation Laws, Nonintertial Reference Frames.
- Introduction to Analytical Mechanics.
- Central Forces.
- Oscillations.
- Rigid Body.
- Special Theory of Relativity.
- General Properties of Wave Phenomena.
- Mechanical Waves.
- Experimental Techniques in Mechanics and Waves.

SKILLS

GENERAL SKILLS

- CG01 - Skills for analysis and synthesis
- CG02 - Organisational and planification skills
- CG03 - Oral and written communication
- CG06 - Problem solving skills
- CG07 - Team work
- CG08 - Critical thinking
- CG10 - Creativity
- CG11 - Initiative and entrepreneurship

SUBJECT-SPECIFIC SKILLS

- CE01 - Knowing and understanding the phenomena of the most important physical theories
- CE02 - Estimating the order of magnitud in order to interpret various phenomena
- CE04 - Medir, interpretar y diseñar experiencias en el laboratorio o en el entorno
- CE05 - Modelling complex phenomena, translating a physical problem into mathematical language
- CE07 - Transmitting knowledge clearly, both in academic as in non-academic contexts
- CE09 - Applying mathematical knowlegde in the general context of Physics

LEARNING OUTCOMES

- Achieve a more profound knowledge of the Newtonian Mechanics, initiated in the first academic year.
- Become familiar with the Lagrangian and Hamiltonian formulations.
- Acquire the knowledge corresponding to the mechanics of vibrations and waves.
- Understand the basic postulates of special relativity and apply them to the development of relativistic kinematics and dynamics.
- Learn to solve typical problems of Newtonian dynamics.
- Learn to study movements in non-inertial reference frames.
- Know how to choose appropriate reference frames for each problem.
- Know how to formulate problems in the appropriate coordinate system.
- Understand the fictitious nature of the forces of inertia.
- Understand the degrees of freedom in the movement of a rigid body.
- Know how to calculate moments of inertia of a rigid body.
- Correctly apply the equations of motion of a rigid body and use conservation principles.
- Use Euler's equations.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

- Chapter 1. Vector Calculus. Field Theory.
- Chapter 2. Newtonian Dynamics: Review
- Chapter 3. Motion in a Non-Inertial Reference Frame.
- Chapter 4. Dynamics Of Rigid Bodies.
- Chapter 5. Analytical Mechanics I: Lagrangian Mechanics.
- Chapter 6. Analytical Mechanics II: Hamiltonian Mechanics.
- Chapter 7. Central Forces.
- Chapter 8. Oscillations.
- Chapter 9. Coupled Oscillations.
- Chapter 10. Wave Phenomena and Mechanical Waves.
- Chapter 11. Introduction to Special Relativity.

PRACTICAL SYLLABUS

In addition to the list of problems proposed for each chapter, there is a catalog of laboratory experiments to be carried out in the Mechanics laboratory of the Department of Applied Physics (http://fisicaaplicada.ugr.es/pages/docencia/mecanica):

- Experiment 1. Observation of Streamlines.

- Experiment 2. Foucault Pendulum.
- Experiments 3-4. Motion Relative to Rotational Frames.
- Experiments 5-6. Rotational Motion, Moment of Inertia and Steiner's Theorem (2).
- Experiments 7-8. Torsional Pendulum, Moment of Inertia and Steiner's Theorem
- (2).
- Experiment 9. Dynamics of the Rigid Solid. Gyroscope.
- Experiment 10. The Brachistochrone and the Tautochrone.
- Experiment 11. Balance of Objects under Uniform Rotation.
- Experiments 12-13. Study of the Oscillatory Motion (2).
- Experiment 14. Study of Motion under Central Forces.
- Experiment 15. Mechanical Rutherford Scattering.
- Experiments 16-17. Coupled Oscillations (2).
- Experiment 18. Interferences with Ultrasound Waves.
- Experiment 19. Standing Waves on a String.
- Experiment 20. Standing Waves on a Wire.
- Experiment 21. Doppler Effect with Ultrasound Waves.
- Experiment 22. Quincke's Interference Tube.

Additional experiments

- Experiment 23. Wave Phenomena with Acoustic Waves.
- Experiment 24. Study of the Double Physical Pendulum.
- Experiment 25. Mechanical Waves at Borders.

RECOMMENDED READING

ESSENTIAL READING

- Classical dynamics of particles and systems / S.T. Thornton and J.B. Marion.
- Classical mechanics / H. Goldstein, C. Poole and J. Safko.
- Mecánica y ondas para fisicxs sin pretensiones / M.A. Rodríguez Valverde.
- Classical mechanics / J.R. Taylor.
- The physics of vibrations and waves / H. J. Pain.
- Schaum's outline of theory and problems of theoretical mechanics with an introduction to Lagrange's equations and Hamiltonian theory / Murray R. Spiegel.
- 101 problemas de mecánica teórica / A. Moncho Jordá.

COMPLEMENTARY READING

- Mechanics / K.R. Symon.
- Mechanics [electronic resource] / L.D. Landau and E.M. Lifshitz; translated from the Russian by J.B. Sykes and J.S. Bell.
- Classical Dynamics: A Contemporary Approach / J. V. José and E.J. Saletan,
- Newtonian Mechanics (M.I.T. Introductory Physics Series) / A.P. French.
- The Feynman lectures on physics / R. Feynman, R. Leighton and M. Sands.
- Physics / M. Alonso and E.J. Finn.
- The classical theory of fields / L. D. Landau and E. M. Lifshitz; translated from the Russian by Morton Hamermesh.
- Classical mechanics simulations: the consortium for upper level physics software.
- Classical Mechanics with Maple [electronic resource] / Ronald L. Greene.
- Vibrations and waves (M.I.T. Introductory Physics Series) / A.P. French.
- Theory and Problems of Lagrangian Dynamics / D.A. Wells.
- Dinámica clásica / A. Fernández Rañada.

- Ondas: teoría y problemas / E. Gaite Domínguez.
- Problemas resueltos de mecánica del punto y de sistemas de puntos / H. Lumbroso.
- Problemas de física / E. Gullón de Senespleda and M. López Rodríguez.
- Theory and Problems of Modern Physics / R. Gautreau and W. Savin.
- Special relativity (M.I.T. Introductory Physics Series) / A.P. French.
- 100 Solved Problems in Classical Physics / A.A. Kamal.

RECOMMENDED LEARNING RESOURCES/TOOLS

ADMINISTRATIVE RESOURCES
https://secretariageneral.ugr.es/sites/webugr/secretariageneral/public/inline-files/examenes.pdf
https://grados.ugr.es/fisica/pages/infoacademica/convocatorias
https://www.ugr.es/~cdocmat/normas_permanencia.pdf
ACADEMIC RESOURCES
http://prado.ugr.es
https://fisicaaplicada.ugr.es/docencia/profesorado
https://www.ugr.es/estudiantes/grados/grado-fisica/mecanica-ondas

TEACHING METHODS

- MD01 - Theoretical classes

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

CONTINUOUS ASSESSMENT will be carried out through informal follow-up controls in class, a written test at the end of the first semester and a final knowledge test, with theoretical-practical questions and problems. In case of obtaining a minimum grade of 4 or higher (out of 10) in the written test at the end of the first semester, the student may not be examined for the corresponding subject in the final exam of the ordinary call. The resolution of the short written tests and the participation, preparation and exhibition of works will also be conveniently valued.
In the case of continuous assessment, attendance at theoretical and problem classes is voluntary, but attendance at all practical laboratory sessions and delivery of all technical reports are mandatory. In case of unjustified absence on the part of the student, they will be evaluated in a similar way to the students who receive the single final evaluation.
In CONTINUOUS ASSESSMENT the final grade will respond to the following scale:
Partial and final written tests on knowledge: 65%.
Completion and delivery of mandatory laboratory reports: 20%.
Short written tests. Preparation and exhibition of works. Class participation: 15%.
To pass the subject, it is necessary to have at least a score equal to or greater than 5 (out of 10) both in the average of the knowledge tests and in the average of the laboratory part. These parts are not compensable.

EXTRAORDINARY EXAMINATION DIET

The final grade will respond to the following scale:
Written knowledge test: 80%.
Individual completion and delivery of the report of ONE laboratory experiment proposed by the teacher: 20%. Prior agreement with the student, the grade of laboratory part will be saved in the case of having passed them in the ORDINARY call.
To pass the subject, it is necessary to have at least a score equal to or greater than 5 (out of 10) both in the knowledge test and in the laboratory practices. These parts are not compensable.

SINGLE FINAL ASSESSMENT (evaluación única final)

In accordance with the regulations of the Universidad de Granada, at the beginning of the course or after supervening justified cause, students who wish to take the single final assessment must request it from the director of the Department of Applied Physics within the established period.
The evaluation will consist of:
Written test based on solving theoretical-numerical problems of the entire program, set on the same day and time and carried out in the same classrooms as the written test for continuous assessment (ordinary call) as for the extraordinary call. This test has a weight of 80%.
Practical laboratory test based on the individual completion of ONE laboratory experiment of the practical syllabus in the Mechanics laboratory and the preparation of the corresponding complete written report in situ. This test is scheduled on the same day, but in a different shift than the written test of the ordinary and extraordinary calls. This test has a weight of 20%.
To pass the subject, it is necessary to have at least a score equal to or greater than 5 (out of 10) both in the knowledge test and in the laboratory part. These parts are not compensable.

ADDITIONAL INFORMATION

The students who resort to the Special Call mentioned in article 21 of the "Rules for Evaluation and Qualification of UGR students", will take a theoretical knowledge and problem-solving exam. If they also had to pass the tests corresponding to the laboratory part, they would have to take a practical exam in the laboratory. The weight of each contribution to the final mark is the same as that indicated for the single evaluation. Following the recommendations of the CRUE and the Secretariat of Inclusion and Diversity of the UGR, the systems of acquisition and evaluation of competences included in this teaching guide will be applied in accordance with the principle of design for all people, facilitating learning and demonstration of knowledge according to the needs and functional diversity of the students.