VNIVERSITAT DE VALÈNCIA

Course Guide
34243 Oscillations and waves

COURSE DATA

Data Subject	
Code	34243
Name	Oscillations and waves
Cycle	Grade
ECTS Credits	4.5
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	2	Second term
1929 - D.D. in Physics-Chemistry	Double Degree Program Physics and Chemistry	2	Second term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	6 - Mechanics and waves	Obligatory
1929 - D.D. in Physics-Chemistry	2 - Segundo Curso (Obligatorio)	Obligatory

Coordination

Name	Department
FONT RODA, JOSE ANTONIO	16 - Astronomy and Astrophysics
NOGUERA PUCHOL, SANTIAGO	185 - Theoretical Physics

SUMMARY

The subject "Oscillations and Waves" is a four-month course of the second year, belonging to the matter "Mechanics and Waves" and has allocated 4.5 credits (38 hours of theoretical and practical classes and 7 h supervised work sessions for problem solving in small groups).

The descriptors proposed in the document Curriculum established to address the following topics: simple oscillator, damped and forced resonance, small oscillations and normal modes, wave equation and solutions, boundary conditions, standing waves, interfaces packages.

Basic objectives in relation to other subjects of the degree

The subject "Physical II" matter "Physics" first course contains aspects of the oscillations and waves to a more basic level and conceptual, focusing on the basics, problem solving and experimental exercises and

demonstrations. The basic objective of this subject "Oscillations and Waves" is to deepen these issues with a greater degree of generalization, formalizing and deepening problems of great interest from a classic Newtonian approach. Although it is intended a general understanding of vibrational and wave phenomena, special attention will be devoted to mechanical vibrations and waves, as they constitute the starting point for understanding and modeling other wave behavior in different areas of physics. Although the subject "Oscillations and Waves" is independent of the subject "Laboratory Experimental Mechanics and Waves", the relationship between the two is very narrow. In particular, students take many practices of vibrations and waves of mechanical nature, such as one-dimensional waves (acoustic tubes, strings, springs) or two-dimensional (Chladni plates), and in all cases dealt with the experimental results from adequacy of knowledge and theoretical models.

In short, this subject has a fundamental and highly relevant for the degree. It deals with a certain degree of mathematical formalization but primarily aimed at providing basic tools to address fundamental problems of waves, affecting the physical content rather than its formulation as a body of theory, more like the course "Mechanics II."

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

The subject "Oscillations and Waves", like other materials second and third year of the Degree in Physics, discusses further aspects and the language studied most basic and conceptual way the contents of the first subject Physics II course. For this reason it is essential to have successfully completed this course. You also need to master the mathematical basis acquired on the subject "Mathematics" in the first course and previous courses (high school).

OUTCOMES

1105 - Degree in Physics

- Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.
- To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.
- Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .
- Theoretical understanding of physical phenomena: have a good understanding of the most important physical theories (logical and mathematical structure, experimental support, described physical phenomena).

- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.
- Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.
- Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.
- Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.
- Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

LEARNING OUTCOMES

- Understand the basic phenomenology of the oscillatory motion, including the damped oscillations, forced oscillations and resonance in specific mechanical problems and general models which are valid in many areas of physics.

- Understand and be able to solve problems in which there is coupling among the equations of motion (coupled systems). In particular, in problems of coupled oscillators as a modellic workframe for vibration pattern in molecules and solids, which leads to the continuous wave description.

- To assimilate the basics of wave motion and in particular the relationship with the properties of the medium. Knowing the type of media that allow the propagation of a deformation as a transverse and/or longitudinal wave. To know (and recognize) typically wave phenomena as interference, diffraction, polarization, pulses, and bandwidth theorem.

DESCRIPTION OF CONTENTS

1. Simple and damped harmonic oscillator

Peridic phenomena. Simple harmonic oscillator. Complex notation. Examples of physical phenomena obeying this model. Harmonic oscillations in two dimensions. Lissajous trajectories. Damped oscillations. Relaxation time. Energy of simple and damped harmonic oscillators.

2. Forced oscillations

Forced oscillator. Transient effects. Harmonic force. Ressonance curce and quality factor. Physical examples of interest. Absortion amplitude and ellastic amplitude. Energy of a forced harmonic oscillator. Superposition principle. Periodic force and Fourier analysis. Non-linear oscillations. Forced non-linear oscillator: combinatory frequencies.

3. Coupled oscillations

Coupling of two oscillators. Symmetric and antisymmetric modes. General theory of small amplitude oscillations. Normal modes. Triatomic linear molecule. N coupled oscillators: vibrations of a crystal lattice. N forced oscillators. Continuum limit.

4. Normal modes of continuous systems

Free vibrations of stretched strings. Wave equation. Solution with boundary conditions: normal modes. Continuous systems. Equations of motion of an ellastic solid. Longitudinal and transverse waves in an ellastic solid. Stationary waves in two and three dimensions. Physical examples.

5. Progressive waves

Stationary and progressive waves. One-dimensional wave equation. Examples. General solution of the wave equation. Phase velocity. Attenuation. Energy of a wave. Superposition of waves and wave packets. Spectral representation of a wave packet and bandwidth theorem. Dispersion relation and group velocity. Waves in two and three dimensions. Waves at interfases: reflection and transmission coefficients. Introduction to ondulatory phenomena: interference, difraction, polarization, Doppler effect.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	38,00	100
Tutorials	7,00	100
Development of individual work	28,00	0
Study and independent work	39,50	0
TOTAL	**112,50**	

TEACHING METHODOLOGY

Contact teaching 40%

Theoretical and practical classes: It addresses the conceptual and formal matter and resolution of problems or cases as the application of theoretical concepts. They are based mainly on lectures with dialogue and the use of teaching tools such as experimental demonstrations, animations or videos, graphic solutions, projected presentations, etc.)..

Group tutoring sessions or work in small groups: focus on student work and their active participation: resolving doubts in dealing with theoretical concepts and problem solving, reinforcement in areas of greatest difficulty, questionnaires conceptual , experimental demonstrations relevant to the case studies and associated with a component of continuous assessment, verification of student progress in the field.

Student's personal work 60%

- Study of the theoretical.

- Troubleshooting individually or in groups

- Individual tutorials: querying of the teacher on student concerns and difficulties encountered in the study and resolution of problems, or discussion on topics of interest, bibliography, etc.

EVALUATION

The assesment system is as follows:

1) Written examinations: One part will assess the understanding of the theoretical-conceptual and formal nature of the subject, both through theoretical questions, conceptual questions and numerical or simple particular cases. Another part will assess the applicability of the formalism, by solving problems and critical capacity regarding the results. Proper argumentations and adequate justifications will be important in both cases. Mark A (between 0 and 10)

2) Continuous assessment: assessment of exercices and problems presented by students, questions proposed and discussed in class, oral presentation of problems solved or any other method that involves an interaction with students. Mark B (between 0 and 1)

Final mark: Group A: max(A, 0,7*A+3*B); Group B: min (10, A+B)

Subject to compliance with the compensation criteria established for this purpose, note this course can be averaged with other others belonging to the same matter, so as to pass the course.

REFERENCES

Basic

- "Vibraciones y Ondas" A. P. French, ed. Reverté, 1996.
- "Dinámica clásica de las partículas y sistemas". J.B. Marion. Ed Reverté, 2000.
- Classical Mechanics John R. Taylor, 2005 University Science Books

Additional

- The Physics of vibrations and waves H.J. Pain. John Wiley & Sons, 2005
- Vibrations and waves del prof. Walter Lewin del MIT (http://ocw.mit.edu/OcwWeb/Physics/8-03Fall-2004/CourseHome/index.htm)
- "Fonaments de Física. Vol. 1,2". V. Martinez (Enciclopedia Catalana).
- "Física II: Campos y Ondas", Alonso Finn. Adison Wesley, 1986.
- Física de Feynman, vol. I, ed Pearson.
- "Waves. Berkeley Physics Course" Kittel-Knight-Ruderman. Ed Reverté, 1999.
- The Physics of Vibration A. B. Pippard. Cambridge University Press, 1989.
- "Mathematical methods for physics and engineering" K. F. Riley et al., Cambridge Univ. Press,

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

In case that health situation requires blended teaching, the teaching model approved by the Academic Degree Committee on July 23, 2020 will be adopted.
For lectures this model consist of 50% student attendance in the classroom, while the rest of students attend the class in streaming broadcast. Two groups will be set with alternate days attendance to the classroom in order to guarantee 50% of teaching hours attendance for all students.
The rest of the teaching activities (laboratories, computer rooms, tutorials) will have a 100% attendance.
If a total reduction in attendance is necessary, classes will be broadcast by synchronous videoconference at their regular schedule, along the period determined by the Health Authority.