Universidad de Navarra

Physics II

Teaching guide 2026-27

PRESENTATION

Brief description:

The main objective of the subject is to learn, understand, relate and study the main concepts of mechanical physics in depth, as already initiated in the baccalaureate. The aim is for students to acquire a basis for the purpose of studying the statics of frictionless mechanical systems and the fundamentals of kinematics and particle dynamics - concepts that can later be extended to the study of mechanical systems formed by non-deformable solids.

In addition, the course aims to influence the development of a critical spirit and interpretation of the results obtained. It will also help the student to make the transition from theoretical concepts to their practical application and will train them in problem solving and the search for the most appropriate procedure to tackle the exercise proposed.

Practically every engineer, throughout their studies and/or professional life will, at some point, face a problem of a mechanical nature. Through this subject, future engineers will acquire the basis and main concepts of mechanical engineering with a view to studying equilibrium and movement, which is why it is considered to be *basic training that is common to all engineering degrees*.

Qualification (Module/Subject):

- Industrial Technologies Engineering (Basic Training/Physics and General Chemistry)
- Mechanical Engineering (Basic Training/Physics and General Chemistry)
- Electrical Engineering (Basic Training/Physics and General Chemistry)
- Industrial Electronics Engineering (Basic Training/Physics and General Chemistry)
- Industrial Organisation Engineering (Basic Training/Physics and General Chemistry)
- Industrial Design and Product Development Engineering (Basic Training/Physics and General Chemistry)
- Biomedical Engineering (Basic Training/Physics and General Chemistry)

Details:

- **ECTS**: 6 ECTS
- **Year, semester**: 1st year, 2nd semester
- **Character**: Compulsory
- **Language**: English

Lecturers in the subject:

- López de Arancibia, Aitziber / Tenured lecturer (alopez@unav.es)
- Csiszar, Gabor / Tenured lecturer (gcsiszar@unav.es)

COMPETENCES

INDUSTRIAL TECHNOLOGIES ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

SC2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with engineering problems.

MECHANICAL ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

GC3 - Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and provides them with the versatility to adapt to new situations.

SC2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with engineering problems.

ELECTRICAL ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

GC3 - Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and provides them with the versatility to adapt to new situations.

SC2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with of engineering problems.

INDUSTRIAL ELECTRONICS ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

GC3 - Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and provides them with the versatility to adapt to new situations.

SC2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with of engineering problems.

TELECOMMUNICATION SYSTEMS ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

SC3 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with engineering problems.

INDUSTRIAL ORGANISATION ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

SC2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with engineering problems.

GC6 - Provide a solid foundation in science, technology, operations management, production and business management.

INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study which builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects involving knowledge deriving from the cutting edge of their field of study.

SC2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application in dealing with engineering problems.

BIOMEDICAL ENGINEERING

BC1 - Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level which, while relying on advanced textbooks, also includes some aspects that involve knowledge deriving from the cutting edge of their field of study.

GC1 - Training must provide the graduate with a solid scientific basis to enable them to rigorously address any professional challenges they may face in the biomedical sector.

COURSE CONTENT

Unit 0. Prior knowledge

Formulas of interest (areas and volumes). - Triangle theorems (sine and cosine). - Definitions of geometry - Trigonometry. - Concept of vector. - Operations with free vectors: scalar product, vector product, mixed product - Applications in analytic geometry.

SECTION 1: VECTOR CALCULUS and MASS GEOMETRY

Unit 1: Vector Calculus

Classification of vectors: free vectors, sliding vectors and bound vectors - Operations with free vectors - Concept of the momentum of a vector with respect to a point. - Sliding vector systems: definition and general resultant. - Resultant momentum of a system of sliding vectors, momentum field law. - Properties of the momentum field of a vector system. - Classification of sliding vector systems - Equivalence of systems.

Unit 2: Mass geometry

Static moments and centres of gravity. - Guldin's theorems. - Determination of centres of gravity by integration. - Composite solids, decomposition into partial figures. - Application in simple cases.

SECTION 2: FRICTIONLESS STATICS

Universidad de Navarra

Unit 3: Frictionless statics

Axioms of Statics. - Concept of mechanical bonding. Bond equation and bond forces. - Classification of bonds. - Equilibrium equations.

SECTION 3: KINEMATICS OF THE MATERIAL POINT

Unit 4: Introduction to Differential Geometry

Vector function of scalar variable. Definition of indicator curve. - Intrinsic trihedron - Frénet formulae. Bending and torsional radii of curvature. - Orthogonal curvilinear coordinates: cylindrical and spherical. - Derivation in bases dependent on a scalar system.

Unit 5: Point kinematics

Vector of position and trajectory - Velocity and hodograph. - Acceleration. Huygens' theorem. - Considerations regarding rectilinear and circular motion of a material point. - Expressions of velocity and acceleration in Cartesian, cylindrical and spherical coordinates.

SECTION: DYNAMICS OF THE MATERIAL POINT

Unit 6: Fundamental theorems of dynamics

Newton's Laws. - Concept of elementary work. - Fundamental theorems of dynamics: linear momentum theorem, angular momentum theorem, energy theorem. - Conservation of energy equation.

Unit 7: Point dynamics

Dynamics of the rectilinear motion of the material point. - Point attached to a curve. - Point bound to a surface. - Point subject to a central force field.

TRAINING ACTIVITIES

The **150-180 h (6 ECTS) set aside** for the Physics II course are divided into the following training activities:

- Theoretical face-to-face classes: 24 hours
- Face-to-face practical classes, laboratories and workshops: 36 hours
- Tutorials: 5 hours
- Personal study: 105 hours
- Evaluation: 7 hours

TEACHING METHODOLOGIES

- Expository classes
- Personal interview with the lecturer in a subject
- Student study based on different sources of information
- Evaluated tests

The face-to-face classes (in the classroom) will include both the **theoretical development of** the subject and **practical exercises**. Please consult the course syllabus and timetable (internal area) to see how the different units are divided in terms of time. Study material (in the internal area) is

available for students to follow the course and for **self-study** aimed at acquiring knowledge, concepts and skills. The study material includes proposed exercises that need to be completed, solutions to the exercises, examples of exams from previous years, videos and tutorials, etc. Lecturers will be available to students to **answer questions** and help, in a more personalised way, in the acquisition of knowledge, skills and abilities.

During the four-month period there will be different **tests to** evaluate student progress, as well as a final exam on the date indicated in the timeline (internal area).

EVALUATION

ORDINARY EXAMINATION SESSION

- **Mid-term and final evaluations**: 100%.

Remarks:

- Throughout the term there will be four tests, accounting for 10%, 15%, 20% and 15% of the final mark respectively. Information on the content and dates of exams can be found in the internal area of the course.
- These exams will be exempting in nature, as long as a minimum of 50% of the mark is reached in each one of them. *On the day of the final exam, students will have to repeat any exams they have not taken during the course*.
- All students will take a compulsory final exam, accounting for the remaining 40% of the mark (4 points). In order to pass the course, a **minimum mark of 25% must be obtained in this compulsory part of the final exam** (1 point).
- Please refer to the internal area of the subject for more detailed information.

EXTRAORDINARY EXAMINATION SESSION (RESITS)

- **Mid-term and final evaluations**: 100%.

Remarks:

- The marks obtained from the assessed tests taken during the course in which the minimum mark was reached in order to exempt the student from this content will be carried forward.
- Likewise, parts passed in the final exam of the ordinary examination session will also be carried forward to the extraordinary examination session (resit).
- Obtaining a minimum mark of 25% in the compulsory part of the final exam (1 point out of 4) that every student must take is still a prerequisite for passing the course.

OFFICE HOURS

- Tutoring hours and place:

BIBLIOGRAPHY

Basic bibliography:

- Various course notes: in the different sessions.
- BASTERO, J.M, CASELLAS, J. and BASTERO, C. " Curso de Mecánica", EUNSA, 5th edition, Pamplona, (2011). Find it in the library (paper version), Find it in the library (electronic version)
- BEER F.P. and JOHNSTON E.R., "Vector Mechanics for Engineers. Statics". (7th. Edition) Edit. Mc Graw-Hill (2005). Find it in the library
- BEER F.P. and JOHNSTON E.R., "Vector Mechanics for Engineers. Dynamics". (6th Edition), Mc Graw-Hill, (1998). Find it in the library

Supplementary bibliography:

- SEARS F., ZEMANSKY M.W. and YOUNG H.D., "University Physics". (11th Edition) Pearson Education (2004).