# COURSE PROGRAM

## Academic Year: 2024/2025

| Identification and characteristics of the course | | | |
|---|---|---|---|
| Code | 501058<br>503010* | ECTS Credits | 6 |
| Course name (English) | Physics II | | |
| Course name (Spanish) | Física II | | |
| Degrees programs | Electrical Engineering (Industrial Fields)<br>Electronics and Automation Engineering (Industrial Fields)<br>Mechanical Engineering (Industrial Fields)<br>*Industrial Technologies Engineering | | |
| Faculty/School | School of Industrial Engineering | | |
| Semester | 2nd | Type of course | Obligatory-Basic |
| Module | Basic Training | | |
| Field | Physics | | |

| Lecturer/s | | | |
|---|---|---|---|
| Name | Office | E-mail | Web site |
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| | |
|---|---|
| Subject Area | Applied Physics |
| Department | Applied Physics |
| Coordinating Lecturer | Carlos Alberto Galán González |

**Competencies *** (see table in http://bit.ly/competenciasGrados)

(ELECTRIC ENGINEERING, ELECTRONIC AND AUTOMATION ENGINEERING, MECHANICAL ENGINEERING)

| Basic | | General | | Transversal | | Specific (Basic Training) | | Specific (Common to Industrial Fields) | | Specific (Specific Technologies) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CB1 | X | CG1 | | CT1 | X | CEFB1 | X | CECRI1 | | CETE1 | |
| CB2 | X | CG2 | | CT2 | X | CEFB2 | X | CECRI2 | | CETE2 | |
| CB3 | X | CG3 | | CT3 | X | CEFB3 | | CECRI3 | | CETE3 | |
| CB4 | X | CG4 | | CT4 | X | CEFB4 | | CECRI4 | | CETE4 | |
| CB5 | X | CG5 | | CT5 | X | CEFB5 | | CECRI5 | | CETE5 | |
| | | CG6 | | CT6 | X | CEFB6 | | CECRI6 | | CETE6 | |
| | | CG7 | | CT7 | | | | CECRI7 | | CETE7 | |
| | | CG8 | | CT8 | X | | | CECRI8 | | CETE8 | |
| | | CG9 | | CT9 | X | | | CECRI9 | | CETE9 | |
| | | CG11 | | | | | | CECRI10 | | CETE10 | |
| | | CG12 | | | | | | CECRI11 | | CETE11 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CECRI12 | | | |

## Competencies * (see table in http://bit.ly/competenciasGrados)

(INDUSTRIAL TECHNOLOGIES ENGINEERING)

| Basic | | General | | Transversal | | Specific (Basic Training) | | Specific (Common to Industrial Fields) | | Specific (Specific Technologi es) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CB1 | X | CG1 | | CT1 | X | CEFB1 | X | CECRI1 | | CETE11 | |
| CB2 | X | CG2 | | CT2 | X | CEFB2 | X | CECRI2 | | CETE12 | |
| CB3 | X | CG3 | | CT3 | X | CEFB3 | | CECRI3 | | CETE13 | |
| CB4 | X | CG4 | | CT4 | X | CEFB4 | | CECRI4 | | CETE14 | |
| CB5 | X | CG5 | | CT5 | X | CEFB5 | | CECRI5 | | CETE15 | |
| | | CG6 | | CT6 | X | CEFB6 | | CECRI6 | | CETE16 | |
| | | CG7 | | CT7 | X | | | CECRI7 | | CETE17 | |
| | | CG8 | | | | | | CECRI8 | | CETE18 | |
| | | CG9 | | | | | | CECRI9 | | CETE19 | |
| | | | | | | | | CECRI10 | | CETE20 | |
| | | | | | | | | | | CETFG | |

## Contents

### Course outline *

Field Theory. Electric and potential fields. Electric current. Direct current circuits. Magnetic field. Electromagnetic induction. Electromagnetic waves.

### Course syllabus

Tiopic 1: **Electric Field and Potential**
Contents of Topic 1:
1.1. Differential operators. The Divergence and Stokes' Theorems.
1.2. Electric field and displacement vector.
1.3. Electric potential. Connection with the electric field.
1.4. Electric flux. 1st Maxwell Equation.

Topic 2: **Conductors, dielectrics and capacitors**
Contents of Topic 2:
2.1. Properties of conductors in electrostatic equilibrium.
2.2. Cavities in a conductor.
2.3. Electric field on the surface of a conductor.
2.4. Dielectrics. Polarization vector.
2.5. Capacitors. Capacitance.
2.6. Energy stored by a capacitor.
**Laboratory session 1**: Plate capacitor
Type: Laboratory.
Duration: 2.5 h

Topic 3: **Electric current and direct current circuits**
Contents of Topic 3:
3.1. Definition. Main physical magnitudes.
3.2. Continuity equation. Steady electric currents.
3.3. Filiform wires. Kirchhoff Rules.
3.4. Ohm's Law.
3.5. Energy dissipation in a conductor: Joule's effect.
3.6. Electromotive force.
3.7. Electric circuits. Resolution methods for direct current circuits.
**Laboratory session 2**: Direct current circuit
Type: Laboratory.
Duration: 2.5 h

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Topic 4: **Magnetostatics**
Contents of Topic 4:
4.1. Magnetic induction vector in vacuum.
4.2. Lorentz force. Force on an electric current element. Force between steady current-carrying conductors.
4.3. Biot-Savart Law. Magnetic field by a moving charge and by a continuous charge distribution.
4.4. Magnetic field intensity in vacuum.
4.5. Ampère's Law. Ampère's Law for filiform currents. Stoke's Theorem. Differential expression of Ampère's Law.
4.6. Magnetic field inside a solenoid.
4.7. Magnetic flux. 2nd Maxwell Equation.
**Laboratory session 3:** Magnetic field in solenoids
Type: Laboratory.
Duration: 2.5 h

**Topic 5: Electromagnetic Induction and Electromagnetic Waves**
5.1. Induced electromotive force. Faraday-Lenz Law.
5.2. Mutual-inductance coefficients.
5.3. Energy stored by a solenoid.
5.4. Maxwell-Ampère Equation.
5.5. Maxwell Equations.
5.6. Electromagnetic wave equation in free space in absence of sources. Flat wave solution. Harmonic wave.
5.7. Energy and power flux of harmonic waves.
5.8. Electromagnetic spectrum.
**Laboratory session 4**: Electromagnetic induction.
Type: Laboratory.
Duration: 2.5 h

**Educational activities ***

| Student workload in hours by lesson | | Lectures | Practical activities | | | | Monitoring activity | Homework |
|---|---|---|---|---|---|---|---|---|
| Lesson | Total | L | HI | LAB | COM | SEM | SGT | PS |
| 1. Electric Field and Potential | 22 | 12 | | | | | | 10 |
| 2. Conductors, Dielectrics and Capacitors. | 22 | 8 | | 2,5 | | | 1,5 | 10 |
| 3. Electric Current and Direct Current Circuits. | 21,5 | 9 | | 2,5 | | | | 10 |
| 4. Magnetostatics. | 24 | 9 | | 2,5 | | | 1,5 | 11 |
| 5. Electromagnetic Induction and Electromagnetic Waves. | 22,5 | 8 | | 2,5 | | | | 12 |
| **Assessment** | | | | | | | | |
| Partial exam | 13 | 2 | | | | | | 11 |
| Final Assessment* | 25 | 2 | | | | | | 23 |
| **TOTAL ECTS** | **150** | **50** | | **10** | | | **3** | **87** |

L: Lectures (100 students)
HI: Hospital internships (7 students)
LAB: Laboratory or field practices (15 students)
COM: Computer room or language laboratory practices (30 students)
SEM: Problem classes or seminars or case studies (40 students)
SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)
PS: Personal study, individual or group work and reading of bibliography

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## Teaching Methodologies *

| Teaching Methodologies (501058) | Used methodologies labelled as "X" |
|---|---|
| 1. Explanation and discussion of theoretical contents. | X |
| 2. Resolution, analysis and discussion of support examples or previously proposed exercises. | X |
| 3. Exposition of related topics by students. | |
| 4. Development of case studies or demonstrations at laboratory, computer room, etc. | X |
| 5. Resolution of specific doubts in small groups in order to identify potential problems in the teaching-learning process, and academic guidance for essays, case studies, practical works, demonstrations, etc. | X |
| 6. Search for information prior to the development of the topics, or for complementary information once they are in progress. | X |
| 7. Preparation of essays, either individually or in groups. | |
| 8. Study of each topic, which may consist of: content study, analysis of practical exercises or case studies, preparation for examinations, etc. | X |
| 9. Technical visits to plants/facilities | |

| Teaching Methodologies (501058) | Used methodologies labelled as "X" |
|---|---|
| 1. Magistral lectures. Explanation of contents by the lecturer. | X |
| 2. Working sessions using case method. | X |
| 3. Exercise solving sessions in classroom. | |
| 4. Development of practical sessions with specialized equipment (laboratories, computer rooms, field work, companies). | X |
| 5. Technical visits to plants/facilities. | |
| 6. Development, writing and analysis, either individually or in groups, of reports, exercises, problems and case studies on related contents and procedures -both theoretical and practical-. | X |
| 7. Assessments, exams, report presentations, etc, either oral or written, and either individually or in groups. | X |
| 8. Individual study. Individual preparation and analysis involving texts, cases, problems, etc. | X |
| 9. Training supervised by the lecturer aimed at identifying potential problems in the training process (via individual interaction between student and tutor), at assessing the learning outcomes out of the classroom as well as at programming the working process of the student to attend non-contact activities like reports, final degree dissertations, etc. | X |

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## Learning outcomes *

Acquire the basic concepts related to Field Theory as well as those of electric field and electric potential, for different charge distributions. Apply the Superposition Principle and identify adavantageous simmetries in order to face practical exercises. Regard Gauss' Theorem as derived from the concepts of solid angle and equipotential surface. Understand the concept of conducting material, also accounting for the case of conductors with internal cavities. Achieve the basic concepts relating dielectrics, at the macroscopic scale, as related to the study of capacitors. Achieve the concept of electric current, continuity equation and electromotive force. Acquire fluency in the resolution of DC electric circuits. Introduce the concept of Lorentz force and expand it to the case of electric currents. Understand the concept of magnetic field created by a point charge and as well as by electric current distributions, stressing the particular case of electric currents flowing along filiform conducting wires. Learn Ampère's Law and apply it to some particular cases of special relevance in engineering, such as infinite rectilinear electric currents and the straight or the toroidal solenoid. Acquire the concept of electromagnetic induction and apply it to standard configurations of interest. Understand the concept of electromagnetic wave.

## Assessment systems

**Assessment criteria:**

CR1. Correct understanding of concepts, theorems and laws involved in the answers to examination questions. Clarity of explanations and coherent use of language will be accounted for (CB1-5, CT1-6, CEFB2).

CR2. Accurate explanations along problem solving. Final solutions will be accounted for only if appropriate units are included and a coherent method is developed (CB1-5, CT1-6, CEFB1, CEFB2).

CR3. Clarity and accuracy in the use of diagrams when appropriate (CB1-5, CT1-6, CEFB2).

CR4. Application of the scientific method (mainly regarding the laboratory sessions) (CB1-5, CT1-6, CEFB2).

CR5. Appropriate group-working habilities (CT8, CT9).

**Assessment activities:**

| | Range | Ordinary call | Extraordinary call | Global evaluation |
|---|---|---|---|---|
| 1.- Final and/or partial examinations | 0% - 80% | 75% | 75% | 75% |
| 2.- Activities dealing with laboratory reports, computer works, case studies, visits, etc. | 0% - 50% | 25% | 25% | 25% |
| 3.- Resolution and hand-in of activities (problems, case reports, essays, project reports, etc.) either individually or in groups. | 0% - 50% | 0% | 0% | 0% |
| | | | | |
| | | | | |
| | | | | |

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**CONTINUOUS EVALUATION MODE:**

**ASSESSMENT ACTIVITY 1.**

A. ELIMINATORY PARTIAL EXAM (EPE): CR1, CR2, CR3
(43 %) NON-REPETEABLE
Written exam including topics 1, 2 and 3 (T1, T2, T3) and accounting for three different scenarios:
a) **EPE ≥ 5 points out of 10**: this part of the subject will be successfully passed and the student should not take another exam on these contents, unless for score improving (anyway keeping the former score if necessary).
b) **4 ≤ EPE < 5 points out of 10**: this part of the subject might be balanced with the second part in the final exam (as long as the weighted average score -see below- in the final exam is equal o greater than 5 points out of 10. This option will be available for both ordinary and extraordinary calls. Students in this scenary could also try to improve the score in this part of the subject in the final exam (although the former score would not be maintained in such case).
b) **EPE < 4 points out of 10**: the exam will not be passed and the contents should be assessed in the final exam.

B. WRITTEN FINAL EXAM (WFE): CR1, CR2, CR3
(75 %) REPEATABLE
It will consist of two well differentiated parts, weighted as 43% y 32% respectively:

- Part 1: T1, T2 and T3
- Part 2: T4 and T5.

The score of each part will be accounted for the extraordinary call whenever it is equal or greater than 4 points (out of 10).
If the score of the partial exam is suitable to be balanced (case "b" in activity A) and the score of part 2 is such that the weighted average is equal or greater than 5 points out of 10, the contents of part 2 will be taken to be successfully passed, as previously stated.

**ASSESSMENT ACTIVITY 2.**
C. LABORATORY REPORTS (*LAB*, out of 10 points): CR1, CR4, CR5
(25%) (In-person sessions in the Laboratory and hand in laboratory report) NON-REPEATABLE
The student should attend 4 sessions in the Laboratory, each of which will include collection of experimental data and handing in a brief laboratory report. Each of these sessions will compute one fourth of the net score corresponding to this activity, so that a total of 2.5 points could be achieved with this activity, whenever the condition explained below is satisfied.

**COMPUTATION OF THE FINAL SCORE OF THE COURSE IN THE CONTINUOUS EVALUATION MODE:**

SCORE WRITTEN FINAL EXAM (WFE) = (0.43 Part 1 + 0.32 Part 2) / 0.75

FINAL SCORE = 0.75 WFE + 0.25 LAB

Conditions to pass the subject:

- WFE ≥ 4 points out of 10, with scores of part 1 and part 2 equal or greater than 3 points out of 10
- FINAL SCORE ≥ 5 points out of 10.

Whenever any of the requirements described in the previous paragraph is not satisfied, the final score of the course will be taken as the minimum value of the two following: the score computed from the expression of the first condition and 4 points.

**GLOBAL EVALUATION MODE**

**ASSESSMENT ACTIVITY 1.**
WRITTEN FINAL EXAM (WFE): CR1, CR2, CR3
(75 %) REPETEABLE
It will consist of two well differentiated parts, weighted as 43% y 32% respectively:

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- Part 1: T1, T2 and T3
- Part 2: T4 and T5.

The score of each part will be accounted for the extraordinary call whenever it is equal or greater than 5 points (out of 10).

No scores of individual parts will be maintained for the extraordinary call.

**ASSESSMENT ACTIVITY 2.**
LABORATORY-CONTENTS EXAM (LAB): CR1, CR4, CR5
(25 %) REPEATABLE
This activity consists of a written examination on the contents of the Laboratory sessions.

**COMPUTATION OF THE FINAL SCORE OF THE COURSE IN THE GLOBAL EVALUATION MODE**

WRITTEN FINAL EXAM SCORE (WFE) = (0.43 Parte 1 + 0.32 Parte 2) / 0.75
FINAL SCORE = 0.75 WFE + 0.25 LAB

Conditions to pass the subject:
- WFE ≥ 4 points out of 10, with scores of part 1 and part 2 equal or greater than 3 points out of 10
- FINAL SCORE ≥ 5 points out of 10.

Whenever any of the requirements described in the previous paragraph is not satisfied, the final score of the course will be taken as the minimum value of the two following: the score computed from the expression of the first condition and 4 points.

## Bibliography (basic and complementary)

**Basic**


- P. Suárez. *Apuntes de Física* (2 vols.). Ed. Escuela de Ingenierías Industriales. UEx
- P. Suárez y C.A. Galán. Manual de laboratorio.


**Complementary**


- Eisberg/Lerner. *Physics. Fundamentals and Applications*. (2 vols). Ed. Mc Graw Hill
- Gettys/Keller/Skove. *Classical and Modern Physics*. Ed. Mc Graw Hill
- Rubio Royo. *Física. Conceptos básicos*. (2 vols). Ed. Interinsular Canaria.
- Serway. *Physics*. (2 vols) Ed. Mc Graw Hill
- Tipler. *Physics*. (2 vols). Ed. Reverté, S.A.
- Alonso/Finn. *Physics. Vol. II Fields*.
- Civit. *Lecciones de Física*. Ed. Doncel, I.G.
- Feynmam. *Physics*. (3 vols). Fondo Educativo Interamericano, S.A.
- Ortega. *Lecciones de Física*. Ed. Universidad de Córdoba.


### Other resources and complementary educational materials

**Web resources**

- http://campusvirtual.unex.es
- http://www.dfists.ua.es/experiencias_de_fisica/index18.html
- http://www.explora.cl/index.php?option=com_content&view=article&id=93&Itemid=75
- http://www.lawebdefisica.com/
- http://www.sc.ehu.es/sbweb/fisica/default.htm
- http://phet.colorado.edu/en/simulations/category/physics
- http://physicsworld.com/
- http://www.physics.org/

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