

## 30150 - Ballistics

### Syllabus Information

**Academic Year:** 2022/23

**Subject:** 30150 - Ballistics

**Faculty / School:** 179 - Centro Universitario de la Defensa - Zaragoza

**Degree:** 563 - Bachelor's Degree in Industrial Organisational Engineering

**ECTS:** 6.0

**Year:** 4

**Semester:** First semester

**Subject Type:** Optional

**Module:**

## 1. General information

### 1.1. Aims of the course

- Obtain the equations of the trajectory of a projectile in the vacuum.
- Explain how the trajectory of a projectile is affected by the atmosphere and aerodynamic drag.
- Apply the necessary corrections to the trajectory of the projectile in order to obtain more realistic results.
- Explain the scatter shooting and its relationship with the rules of the shot.
- Determine the forces and momenta acting on a projectile as a result of air resistance.
- Apply the modified point mass model in order to improve the ballistic calculations in the determination of trajectories.
- Evaluate the different effects that can be achieved with the different projectiles and in what kind of objectives each ammunition is used.
- Evaluate the use of ordnance and rocket artillery ammunition according to the objective. Study of advantages and disadvantages.
- Explain the need to homogenize the effects of projectiles within the NATO countries.

Specialization in Defence: These approaches and objectives are in line with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (<https://www.un.org/sustainabledevelopment/>), in such a way that the acquisition of the course learning outcomes provides training and competence to contribute to their achievement to some degree: Industry, innovation and infrastructure (9); Peace, justice and strong institutions (16).

### 1.2. Context and importance of this course in the degree

Specialization in Defence: The subject is part of the training of the future Army Officers, providing basic knowledge of ballistics and the behaviour of projectiles and developing the skills needed by Army Officers of the fundamental specialty Artillery to carry out their mission and contribute to the development of their professional career.

### 1.3. Recommendations to take this course

It is a subject of the specialty "Radar and Missile Systems". The student has passed most of the degree until the third year, so he should be able to successfully complete it. More specifically, in order to be able to follow this subject without difficulty and to be able to overcome it successfully, the student must have knowledge of algebra, differential and integral calculus in one and several variables, kinematics and dynamics.

## 2. Learning goals

### 2.1. Competences

C02 - Ability to plan, budget, organise, manage and monitor tasks, people and resources.

C04 - Ability to solve problems and take decisions with initiative, creativity and critical reasoning.

C06 ? Ability to communicate knowledge and skills in Spanish.

C09 ? Ability to work in a multidisciplinary group and in a multilingual setting.

C11 ? Ability to continue learning and develop self-learning strategies.

C58 - Familiarity with the fundamentals of Mathematics, Ballistic and Guided Missile Systems applicable to firing procedures for Artillery Weapons Systems.

## 2.2. Learning goals

The student, to overcome this subject, must demonstrate having achieved the following learning outcomes:

- Analyze the movements of a projectile inside and outside the barrel.
- Analyze the interactions between projectile and cannon.
- Recognize the mechanisms of penetration, destruction, fragmentation and the necessary protection.
- Calculate the ballistic dispersion.
- Predict the effects produced by a projectile.

## 2.3. Importance of learning goals

The student who passes this subject will have achieved the learning results mentioned in the previous section. All of them are basic for a future Gunner Lieutenant of the Spanish Army. In addition, these results are the basis for continuing his studies in the corresponding Artillery Academy.

# 3. Assessment (1st and 2nd call)

## 3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

### FIRST CALL

Continuous assessment:

The students will be able to pass the total of the subject by the continuous assessment procedure. To do this, they must demonstrate that they have achieved the expected learning outcomes by passing the assessment instruments indicated below, which will be carried out throughout the semester:

- Individual coursework. Throughout the semester, different tasks will be carried out that will be part of the continuous evaluation of the subject. The specific number of activities will be determined by the development of the Subject throughout the course. Its weight in the final grade is 20%.
- Group work. There will be a group work on one of the contents of the subject that students must submit and exhibit in the classroom. Its weight in the final grade is 40%.
- Exam. There will be a written exam of the theoretical-practical contents of the subject. Its weight in the final grade is 40%.

In the final mark of the continuous assessment (100%) all the assessment instruments carried out throughout the course and its weight will be taken into account. To pass the subject, the student's final grade must be equal to or greater than 5.

Final Exam:

The students who do not pass the subject by continuous assessment or who would like to improve their grades, will have the right to take the Final Exam set in the academic calendar, prevailing, in any case, the best of both grades. This global assessment will be equivalent to the continuous assessment test described and will have the 100% weight in the final grade. This Final Exam will consist of an individual written exam whose contents may have both theoretical and practical nature. To pass the subject, the student's final grade must be equal to or greater than 5.

### SECOND CALL

Final Exam:

The students who do not pass the subject in the first call may take the Final Exam set in the academic calendar for the second call. This Final Exam will consist of an individual written exam whose contents may have both theoretical and practical nature. To pass the subject, the student's final grade must be equal to or greater than 5.

### ASSESSMENT CRITERIA

- The understanding of the ballistics concepts used to solve the problems.
- The use of appropriate strategies and procedures in their resolution.
- The use of clear and detailed explanations justifying the answers.
- The correct interpretation of the obtained results.
- The correct use of the terminology and the notation of the subject.
- The orderly, clear and organized exposition of the used procedures.
- The proper use of software, if applicable.
- The result and final quality of the work, if applicable.

## 4. Methodology, learning tasks, syllabus and resources

### 4.1. Methodological overview

The approach, methodology and assessment of this course is prepared to be equivalent in any teaching scenario. It will be adjusted to the socio-sanitary conditions of each moment, as well as to the indications given by the competent authorities.

The learning process designed for the course is based on the following items:

- Lectures.
- Theoretical essays and practical assessments, complemented by real experiments.
- Computer lab sessions where students should show their knowledge of the theoretical bases of the subject.
- Active learning: solving problems and studying topics posed by the teacher.

### 4.2. Learning tasks

The learning activities are detailed in the section 3.

### 4.3. Syllabus

#### Interior Ballistics

1. Interior ballistic elements.
2. Fuzes, bombs and multipliers.
3. Interior ballistic in ordnance.

#### Exterior Ballistics

- Vacuum ballistic.
- Projectile equation in atmosphere.
- Aerodynamic drag.
- Point mass model.
- Ballistics corrections.
- Rigid body model.
- Dispersion Measures.
- Shooting table.

#### Terminal Ballistics

- Introduction
- HE projectile effects.
- AP projectile effects.
- Special projectile effects.

### 4.4. Course planning and calendar

The schedule of lectures and assessment tasks and essays submission deadlines will be announced by the professor in class and on the Moodle platform (ADD).

There are two kind of activities in the course.

The class activities are:

- Lectures
- Problem solving classes
- Computer lab sessions
- Essay presentations

Homework:

- Group activities and essays
- Practical assessments
- Self-study

Key dates (exams and deadlines) will be announced by the profesor in class and in the Moodle platform.

#### **4.5. Bibliography and recommended resources**

Bibliography available at: <http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=30150>