

Academic Year/course: 2021/22

## 30150 - Ballistics

### Syllabus Information

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**Academic Year:** 2021/22

**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.

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

The subject is part of the Optional Module "Radar and Missile Systems" of the Bachelor's Degree in Industrial Organisational Engineering of the University of Zaragoza (Defense profile). This subject is part of the training that the student receives to be part, in the future, of the fundamental specialty of Artillery of the Spanish Army.

### 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)

To evaluate the subject, a continuous evaluation assessment. In this subject we consider the following assessment tasks:

- **Individual coursework.** Throughout the semester, different task 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.
- **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.
- **Final exam.** There will be a final test of the theoretical-practical contents of the subject.

Each of these three blocks will have a rating from 0 to 10 (both included).

In the 1st call, the final grade obtained is the result of the following formula:

$$FG = 0.2 \text{ Individual coursework} + 0.4 \text{ Group work} + 0.4 \text{ Final exam.}$$

Any students who either does not opt for the continuous assessment option or does not pass the subject with this option or wishes to improve his grade has the possibility of taking a global assessment of 100% of the contents of the subject. The final grade of the subject corresponds to the greatest of the obtained grades.

A student passes the subject if he obtains, as a final grade, a value greater than or equal to 5.

In the 2nd call, there will be a single exam that will constitute 100% of the grade.

# 4. Methodology, learning tasks, syllabus and resources

## 4.1. Methodological overview

If this teaching could not be done in person for health reasons, it would be done telematically.

The learning process designed for 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 course
- 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>