Course Guide:

Scenarios 1, 2 y 3:

GENERAL PHYSICS

CHEMISTRY DEGREE
COMPLUTENSE UNIVERSITY OF MADRID
ACADEMIC YEAR 2021-2022

SCENARIO 1. FACE-TO-FACE

I.- IDENTIFICATION

COURSE NAME:	**General Physics**
CREDITS (ECTS):	**9**
CHARACTER:	**Basic Formation**
SUBJECT:	**Physics**
MODULE:	**Basic**
DEGREE:	**Bachelor in Chemistry**
SEMESTER:	**Annual (first year)**
DEPARTMENTS:	**Materials Physics** **Physics of the Earth and Astrophysics** **Theoretical Physics** **(Facultad de Ciencias Físicas)**

RESPONSIBLE LECTURERS:

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II.- OBJECTIVES

■ GENERAL OBJECTIVES

- The knowledge of physics required for other courses during the degree, and the necessary content to maintain the logical structure of the course and to equalize the previous training of the students.
- The ability to apply this knowledge, and thereby acquire the skills necessary for:
  - Identifying theoretical models.
  - Recognising the relevant physical variables of a particular phenomenon.
  - Applying general laws and principles.
  - Interpreting specific physical conditions to describe them quantitatively.
  - Acquiring experimental skills.
  - Acquiring skills of interpretation and analysis, assessing results, and identifying the implications and relations that arise from them.

The aim is to provide the student with:

(1) The ability to assimilate the disciplines of the degree that are based on the content of the course.

(2) The ability to apply theoretical models from the course to real-world situations, and to critically evaluate the result.

(3) Rigor, mental agility, and to familiarise the student with the use of scientific-technical methods from the course, for further training and professional practice.

■ SPECIFIC OBJECTIVES

Among the specific objectives, the following should be emphasised:

- To have a clear understanding of fundamental and derived physical quantities, and the units used to measure them.
- To consolidate the understanding of the principles of Newtonian mechanics.
- To relate work and energy, and to know how to solve problems solely on the basis of energetic considerations.
- To acquire the basic understanding related to the notion of field, with a special emphasis on the electric and magnetic fields and also on the electrostatic forces and potentials produced by ions and molecular dipoles.
- To apply the concept of field to the study of the electric field produced by electrical charges and to the study of the the magnetic field produced by moving charges.
- To study the behaviour of electrical charges and currents inside electric and magnetic fields.
- To study the ability of mechanical and electromagnetic waves to transport momentum and energy.
- To understand electromagnetic radiation and its spectrum.
- To understand the fundamentals of physical optics, in particular those related to interference and diffraction of waves.

III.- PREVIOUS KNOWLEDGE AND RECOMMENDATIONS

- **PREVIOUS KNOWLEDGE:**

It would be useful for students who have registered in this course to have studied physics and mathematics in the last year of the Baccalaureate. Similarly, a knowledge of vector calculus, and differential and integral calculus would be useful.

- **RECOMMENDATIONS:**

IV.- CONTENTS

- **BRIEF DESCRIPTION:**

Physical quantities, units and dimensional analysis. Classical mechanics and Newton's laws. Work and energy. Systems of particles. Fluids. Oscillatory and wave motion: mechanical waves and electromagnetic waves. Electrical potential and electric field. Magnetic field and magnetic induction. Wave optics.

- **SYLLABUS:**

FIRST SEMESTER

Unit 1: Systems of units and vectors

- Physical quantities. Systems of units.
- Dimensional analysis.
- Vectors: definition and frames of reference.
- Vector operations.
- Cartesian representation of a vector. Unit vector.

Unit 2: Kinematics of a particle

- Vectors of position, velocity, and acceleration.
- Classification of motion.

Unit 3: Dynamics of a particle. Newton's laws

- Newton's laws.
- Important types of forces.
- Impulse of a force.
- Dynamics of circular motion: components of the force.

Unit 4: Work and energy

- Work.
- Power.
- Kinetic energy.
- Potential energy: conservative forces.
- Conservation of mechanical energy.
- Non-conservative forces: conservation of energy.
- Work-energy theorem.
- Analysis of potential energy curves.

Unit 5: Systems of particles I: linear momentum and collisions

- Centre of mass (CM). Calculation of the CM of systems of discrete particles.
- Translational motion of the CM of a system of particles.
- Conservation of linear momentum.
- Energy of a system of particles: conservation of energy.
- Collisions.

Unit 6: Systems of particles II: rotation and angular momentum

- Rotational motion of the CM of a system of particles: moment of a force, moment of inertia, and angular momentum.
- Rotational dynamics of a system of particles.
- Conservation of angular momentum.
- Rotational kinetic energy.

Unit 7: Fluids

- Pressure at a point in a fluid.
- Viscosity.
- Fluids in motion:
    - Conservation of material: equation of continuity
    - Conservation of mechanical energy: Bernouilli equation.
    - Conservation of energy applied to viscous fluids: Poiseuille equation.
- Surface tension. Capillarity.

Unit 8: Oscillatory motion

- Definition of simple harmonic motion (SHO).
- Elastic force: Hooke's law.
- General equation of SHO. Parameters governing harmonic motion.
- Potential, kinetic, and mechanical energy of a harmonic oscillator.
- Examples of simple harmonic oscillators: mass on a spring and the simple pendulum.

SECOND SEMESTER

Unit 9: Waves

- Definition of waves. Wave function.
- Types of waves.
- Speed of waves. Wave equation.
- Harmonic waves.
- Waves and barriers.
- Principle of superposition of waves.
- Interference of harmonic waves.
- Standing waves.

Unit 10: Properties of light

- Electromagnetic waves. Electromagnetic spectrum.
- Light spectra.
- Sources of light. Absorption, scattering and stimulated emission.
- Propagation of light. Principles of Huygens and Fermat.
- Reflection and refraction.

- Interference phenomena.
- Diffraction phenomena.

Unit 11: Electric field

- Electric charge.
- Conductors and insulators.
- Coulomb's law.
- The electric field.
- Electric field lines.
- Motion of point charges in electric fields.
- Electric dipoles.
- Electric flux.
- Gauss's law. Applications to calculate the electric field.
- Charge and field at conductor surfaces.

Unit 12: Electric potential and electrostatic potential energy

- Electrostatic potential energy. Electric potential.
- Potential and electric field lines.
- Potential due to a system of point charges.
- Computing the electric field from the potential. General relation between field and potential.
- Calculations of the potential for continuous charge distributions.
- Equipotential surfaces. Dielectric breakdown.
- Capacitors.
- Storage of electric energy.
- Dielectrics.

Unit 13: Electric current and direct-current circuits

- Electric current and the motion of charges.
- Ohm's law and resistance.
- Electric energy and electric power.
- Electromotive force in circuits.
- Combinations of resistors in series and in parallel.

Unit 14: Magnetic field

- Magnets and magnetic poles.
- Force exerted by a magnetic field.
- Motion of a point charge in a magnetic field.

Unit 15: Sources of the magnetic field

- Magnetic field of moving point charges.
- Magnetic field of currents: The Biot-Savart law.
- Ampère's law.
- Atomic magnetic moments.

Unit 16: Magnetic induction

- Magnetic flux.
- Induced electromotive force and Faraday's law.
- Lenz's law.

- **LABORATORY PRACTICALS:**
  - Determination of refractive index.
  - Magnetic field produced by currents.
  - Stationary waves on a string.
  - Pendulum (oscillations).

V.- COMPETENCES

- **GENERAL:**
  - **CG2:** To recognise the importance of chemistry to other areas, and its relation to other disciplines.
  - **CG3:** To be able to progress to more specialised areas of chemistry, or multidisciplinary areas.
  - **CG7:** To recognise and analyze new problems and plan methods to solve them.
  - **CG12:** To interpret data and observations made in the laboratory in terms of their significance and the theories that underly them.
  - **CG13:** To develop good scientific practices in measurement and experimentation.

- **SPECIFIC:**
    - **CE23:** To use the fundamental physics quantities and their derivatives, the system of units in which they are measured, and the equivalencies between them.
    - **CE23-F1:** To explain phenomena and processes related to basic aspects of physics.
  - **CE24:** To make use of the principles of mechanics and the relationships between them, applying them to the motion of a particle, to systems of particles, and to fluids.
    - **CE24-F1:** To describe and make use of the principles of Newtonian mechanics, and the relations which arise from them.
    - **CE24-F2:** To describe and use the fundamentals of fluid mechanics.
    - **CE24-F3:** To describe basic concepts related to wave motion, its essential characteristics, and the principle of superposition.
  - **CE25:** To apply the concepts of field, electric and magnetic field to phenomena related to electrostatic forces and potentials, electromagnetic radiation and optical phenomena.
    - **CE25-F1:** To formulate and use basic knowledge relative to the concept of field, with a special emphasis on the electric and magnetic fields

- **CE25-F2:** To demonstrate and use basic knowledge regarding electromagnetic radiation and its spectrum and understand the fundamentals of physical optics.

- **GENERIC:**
  - **CT2:**To work as a team.
  - **CT3:** To demonstrate critical thinking and self-criticism.
  - **CT4:** To be able to adapt to new situations.
  - **CT7:** To use software packages to treat experimental data.

VI. – LEARNING OUTCOMES

Having passed this course, the student should be able:

Unit 1

1. To know that the measurement of a physical quantity consists of a number expressed in suitable units.
2. To be able to distinguish between scalar variables and vectors.
3. To know the fundamental units that form the International System of Units (SI), as well as other historical systems of measurement, and other frequently used units that do not form part of the SI.
4. To use dimensional analysis as a tool to derive the functional dependence between physical quantities.
5. To perform basic operations of vector algebra: addition, multiplication by a scalar, and the scalar and vector products.
6. To express a vector in terms of basis vectors. Application to orthonormal coordinate frames.

Unit 2

7. To calculate the instantaneous and mean velocity and acceleration of a particle, given its space-time coordinates.
8. To identify the type of motion of a particle (uniform or uniformly accelerated) and calculate the physical quantities: position, velocity, and acceleration from the equations of motion.
9. To describe the motion of a particle in a plane as a composition of motion in two dimensions, and to apply it to parabolic motion.
10. To calculate the physical quantities that describe the circular motion of a particle, from the equations that govern its movement.
11. To describe the motion of a particle in different inertial reference frames.

Unit 3

12. To know Newton’s laws.
13. To know the main types of forces found in nature.
14. To apply Newton’s second law to solve the classical dynamics of a particle.
15. To apply Newton’s second law to circular motion.

Unit 4

16. To explain the concept of the work done by a force, and be able to calculate it.
17. To define the kinetic energy of a body, and understand its physical significance.

18. To explain that work done on a body changes its kinetic energy, and to use this result to describe the behaviour of bodies in motion.
19. To define and calculate the power supplied by a force that is performing work.
20. To understand the difference between conservative and non-conservative forces.
21. To define potential energy, and to calculate it for a given form of force.
22. To state the principle of the conservation of mechanical energy, and use it to solve problems in which all the forces are conservative.
23. To state the general principle of the conservation of energy, and use it to solve problems involving both conservative and non-conservative forces.
24. To interpret energy diagrams, and extract information from them describing the motion of an object under the influence of a conservative force.

Unit 5

25. To calculate the centre of mass of a system of particles.
26. To calculate the centre of mass of an extended object.
27. To analyze and determine the movement of a system of particles subject to internal and external forces by using the concept of the centre of mass.
28. To analyze and determine the movement of an extended object subject to external forces by applying the concept of the centre of mass.
29. To calculate the linear momentum of a particle and an extended object.
30. To calculate the energy of a system of particles, and apply the principle of conservation of energy.
31. To understand the concept of a collision, and to apply it to different physical situations.
32. To distinguish between the different forms of collison: elastic, totally inelastic, and inelastic.
33. To calculate the parameters of motion resulting from a collision.

Unit 6

34. To understand that the moment of a force is the origin of rotational movement about the centre of mass of a system of particles, and to calculate it for different cases.
35. To understand that the moment of inertia is a measure of the rotational inertia of a body. To calculate it for a system of particles, and for rigid geometrical bodies such as cylinders, spheres, etc.
36. To understand the concept of angular momentum, and to relate it to linear momentum.
37. To solve the rotational dynamics of systems of particles, using the fundamental equation of rotational dynamics.
38. To know the theorem of the conservation of angular momentum, and to apply it to definite problems.
39. To understand rotational kinetic energy, and to relate it to translational kinetic energy.

Unit 7

40. To define what a fluid is, and to understand the significance of the density and pressure of a fluid.
41. To explain the significance of the fundamental equation of hydrostatics and Pascal's law, and to apply it to fluids at rest..
42. To know the principle of Archimedes, and to use it to solve floating-body problems.

43. To classify the different regimes in which a fluid can move.
44. To know the continuity equation and the Bernouilli equation, and to apply them to the study of fluids in motion.
45. To define the concept of the viscosity of a fluid, and to derive the effects that it has on the movement of fluids by applying Poiseuille's equation.
46. To define surface tensión, and explain its physical significance.
47. To justify why capillarity occurs and to apply Jurin's law.

Unit 8

48. To define simple harmonic motion (SHO).
49. To know Hooke's law.
50. To understand the general equation of a harmonic oscillator, and to describe the parameters which define it.
51. To calculate the potential, kinetic, and mechanical energy of a harmonic oscillator.
52. To apply the concepts to other oscillator systems.

Unit 9

53. To understand the concept of waves and their description with the wave function.
54. To distinguish the types of waves (longitudinal and transverse).
55. To calculate the speed of waves in different material mediums.
56. To recognize the wave equation and identify the different terms in it.
57. To understand the concept of harmonic waves and their relevance and identify the parameters that characterized them (amplitude, period, frequency, wave number, speed, energy).
58. To describe the behaviour of waves when they encounter barriers. To calculate the fraction of transmitted and reflected power using the information of the wave amplitude, wave speed and density.
59. To explain the principle of superposition of waves. To apply it to the superposition of harmonic waves and be able to justify constructive and destructive interference.
60. To explain the concept of standing waves, write the standing-wave condition and calculate the natural frequencies.

Unit 10

61. To explain the concept of electromagnetic waves and electromagnetic spectrum.
62. To describe light spectra.
63. To interpret absorption, scattering and stimulated emission.
64. To apply the principles of Huygens and Fermat to light propagation problems.
65. To understand reflection and refraction phenomena.
66. To explain interference phenomena.
67. To explain diffraction phenomena.

Unit 11

68. To describe the concept of electric charge as a consequence of the transference of electrons.
69. To differentiate between conductors and insulators, relating their electric response to the type of bonding.
70. To know Coulomb's law as the basic electrostatic interaction, and the order of magnitude of the electric force compared with other types of interactions.

71. To explain the concept of electric field and the characteristics of the vector describing it. To know the relation between the electric field and the electric force.
72. To determine the electric field due to a system of point charges and for some cases of continuous charge distributions.
73. To use the electric field lines as a representation of the electric field and know their distribution in the case of the electric field created by a point charge, a dipole and for a uniform field.
74. To explain the concept of electric dipole and dipole moment and to know the electric field due to an electric dipole in its vicinity and far away from it.
75. To understand the concept of electric flux and determine it for open and closed surfaces.
76. To know Gauss's theorem and apply it to calculate the electric field produced by charge distributions that have certain symmetries.
77. To know the value of the electric field near the surface of a conductor, and the response of the conductor to electric fields.

Unit 12

78. To understand and describe the concepts of electrostatic potential energy and electric potential.
79. To understand what the electric field lines represent and their relationship with the electric potential. To determine the electric field from the the potential using the relation between them.
80. To know the expression of the potential due to a system of point charges and a continuous charge distribution and to calculate the potential for simple cases.
81. To explain what equipotential surfaces represent and use them to visualize the spatial changes in electric potential.
82. To explain the meaning of dielectric breakdown and the conditions under which it takes place.
83. To describe a capacitor and know its applications. To define and calculate the electric capacitance of some capacitors with simple geometry.
84. To identify and calculate combinations of capacitors connected in series and in parallel.
85. To describe a dielectric is and its relation with capacitors.

Unit 13

86. To explain what an electric current represents and how it is generated.
87. To explain the concept of electric resistance and resistivity, and calculate the resistance of a conductor knowing its dimensions.
88. To know and apply Ohm's law.
89. To distinguish and define the concepts of electric energy and power in circuits.
90. To explain what the electromotive force represents in circuits.
91. To identify and calculate the combination of resistances in series and in parallel.

Unit 14

92. To know the properties of magnets and how they interact among themselves.
93. To describe and calculate the force exerted on a moving charged particle in a magnetic field.
94. To explain the differences between the electric and magnetic field lines.
95. To determine the trajectory of a charged particle moving in a magnetic field.
96. To apply the previous knowledge to study the motion of charged particles in magnetic fields and interpret the results.

97. To determine the magnetic forces on current-carrying wires.
98. To describe the behaviour of current loops in magnetic fields.

Unit 15

99. To explain the nature of the magnetic field produced by a moving point charge.
100. To describe the magnetic field produced by a current element.
101. To calculate the magnetic field due to an infinitely long straight current-carrying wire..
102. To calculate the force between long current-carrying parallel wires. To determine if it is an attractive or a repulsive force.
103. To calculate the magnetic field due to a current loop.
104. To know Ampère's law and apply it to the calculation of the magnetic field due to high symmetry current distributions.

Unit 16

105. To justify the experimental evidence of the induction of an electromotive force (emf) due to a variable magnetic field.
106. Relate the induced emf in a loop with the change in magnetic flux through the loop using Faraday's law.
107. To determine the direction of the induced emf.
108. To calculate the emf induced in a conductor due to its motion in a region in which there exists a magnetic field.
109. To explain the way in which a variable magnetic field produces an electric field.

VII. –WORKING HOURS DISTRIBUTED BY ACTIVITY

Activity	Attendance (hours)	Self-study (hours)	Credits
Lectures	42	58	4
Seminars / Problem classes	35	25	2.4
Tutorials / Guided work	7	10.5	0.7
Laboratory	12	9	0.84
Written assignements and exam preparation	6	20.5	1.06
Total	**102**	**123**	**9**

VIII.- METHODOLOGY

1. **Lectures:** at the start of each unit, the content and objectives will be explained. At the end of each unit there will be a brief summary of the most important points covered
2. **Seminars / Problem classes**: exercises and problems will be set for the students with the aim of testing their understanding of the material covered in the lectures. Solutions to some of the problems will be presented in class, to allow students to follow the procedure, and the results and their implications will be discussed.

3. **Tutorials**: these are dedicated problem-solving classes for the students. The professor will act as a tutor and supervise the students' work.
4. **Guided work**: these activities are aimed at developing habits of self-study. The student (or group of students) must solve various exercises out of the classroom. In addition, the student could prepare and present in class a short project on the contents of the course.
5. **Periodic tests:** these will allow continuous evaluation of the progress of the student during the course.
6. **Laboratory practicals:** these enable the student to learn the scientific method. By performing and analyzing various experiments, they will determine if the starting hypotheses are true. In addition, they will learn to make an error analysis of experimental data.

IX.- BIBLIOGRAPHY

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- **COMPLEMENTARY:**
  - Serway, R.A., Jewett, J.W., Peroomian V.: "*Physics for Scientists and Engineers*". 9Th ed., [international ed.] ed. Pacific Grove: Brooks/Cole, Cengage Learning; 2014.
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  - C. Sánchez del Rio, "*Análisis de Errores*", Eudema, España, 1989.

X.- ASSESSMENT PROCEDURE

In this course each semester can be passed separately and the passed marks, including the one related to the laboratory, are also used if needed in the final results in the re-sit. In each semester the following will occur:

- A midterm exam, "C", in the middle of the semester.
- A Partial exam, "P", at the end of the semester.
- Continuous Evaluation, "EC", based on homework, short tests, projects, tutorials, class participation etc.

The **Final Mark** ol the course, “FM”, will be given by:

$$FM=0,85.A + 0,15.L$$

where:

- $L = 0,5.M + 0,5.ExL$

  L: Laboratory mark
  M: mark of the laboratory reports
  ExL: mark of the laboratory exam

- A is the arithmetic mean of the results obtained in each semester, “B”, and is evaluated for each one as:

$$B = Ex + 0,3.EC\left(\frac{10 - Ex}{10}\right) \text{ with } Ex = P + 0,2.C\left(\frac{10 - P}{10}\right)$$

  Ex: mark of the exams
  P: mark of the Partial exam
  C: mark of the Control exam
  EC: mark of the Continuous Evaluation

- All marks are scored out of 10.
- Necessary conditions to pass the course are:

- $L \geq 5$
- $A \geq 5$
- $P \geq 4$
- $ExL \geq 4$
- $M \geq 4$

In addition:

- $C \geq 4$ in order for the midterm exam mark to be included in the calculation of the mark of the exams (Ex)

- Students who do not pass one or more of the semesters can attend a Final Exam in June and a re-sit in July. Both these exams will consist of two parts (corresponding to the first partial and to the second partial). The mark obtained in each of these parts will be used in the formula for “Ex” in the place occupied by “P”.

It is possible to compensate marks between semesters only if the score obtained for them, “B”, is above 4. Compensable semesters marks will be retained for both the Final Exam and the re-sit.

SCENARIO 2. BLENDED

VIII.- METHODOLOGY

- **Theory and seminar classes** taught by the teacher as in Scenario 1, with the same content. In accordance with UCM's principle of maximum face-to-face time, students will follow the session in class until maximum capacity is reached, taking into account social distancing. If there is not enough space and the classroom is provided with a camera, the surplus students will follow the class on-line, from their home or from a public space provided by the Faculty, which will be clearly indicated in the CV. For classrooms not provided with a camera, rotation shifts will be scheduled for face-to-face classes, taking into account students' DNI. This procedure can be modified by the teacher throughout the course, as he/she deems necessary, to adjust the classroom capacity to the number of students attending the classes. More details are provided in the following:
  - The teaching material will consist of the same presentations used in scenario I, or notes on the subject provided through UCM's Virtual Campus, as well as recordings related to the subjects and other types of teaching materials, which the teacher deems relevant for the subject. All the teaching material will be provided to students in advance by means of the Virtual Campus.
  - Platforms used for students to follow on-line sessions will be: Google Meet, Microsoft Teams or Zoom. The teacher will keep one of these types of session open to allow direct and fluid contact with on-line students, so that a presentation, or other documentation, or a screen from a digital tablet can be projected, and blackboard explanations can be followed.
  - Alternatively, among other modifications proposed by the teachers, a "flipped learning" modality of classes is envisaged, in which theoretical asynchronous classes will be provided through the CV, while face-to-face sessions will be devoted to work on problems and conceptual questions derived from the theoretical classes.

- **Laboratory practicals** planned with a minimum presentiality of 60% to allow for the required social distancing. According to the details of each experiment, presentiality might be slightly modified. The organization of the experimental classes rests on the following aspects:
  - A test will be solved before each session.
  - Practical sessions are structured in three parts: a theoretical-practical introduction, experimental procedure, and data analysis.
  - The experimental procedure will be developed face-to-face. If this will not possible, recorded material or commercial videos will be used
  - The other two parts will be taught according to any of the following methods, or a combination of them:
    (a) Face-to-face, in a classroom that allows greater social distancing.
    (b) On-line in synchronous sessions.
    (c) On-line in asynchronous sessions.

- The teaching material employed will be the same as the one used in Scenario 1, in addition to other written material like notes, numerical results, graphics and/or PowerPoint presentations with explanations.
- All the material will be available in advance for the students through the Virtual Campus.

- **Individual tutorials**
  They will be held by video-conference and/or email.

- **Student monitoring**
  Traditional methodologies will be followed for the face-to-face teaching part.
  For on-line teaching, monitoring will be conducted by the use of different technologies, according to the decision of the teacher: registry activity tools for each session (Teams), name of attendants (Google Meet), signing sheet in the CV programmed as a questionnaire, analysis of downloading activity by students in the CV, etc.

X.- EVALUATION

Face-to-face exams as in Scenario 1 will be performed.

SCENARIO 3. ON-LINE

VIII.- METHODOLOGY

- **Theory and seminar classes** will be taught in combined (a) synchronous (at the official time of the class) and (b) asynchronous sessions.
  - The teaching material will be the presentations used in Scenarios 1 and 2, PowerPoint presentations accompanied by voice recording with the necessary explanations, as if it were a face-to-face session, or notes on the subject explained in recordings, video recordings with explanations and other types of material teachers deem appropriate, available through the Virtual Campus.
  - On-line platforms to be used are the same as the ones in Scenario 2: Google Meet, Microsoft Teams or Zoom.

- **Laboratory practicals** will be developed as in scenario 2, replacing the face-to-face experimental procedure following different alternatives: written material as tutorials where the procedure is described in detail, recordings of the experiment, recordings with lecture demonstrations similar to the experiments that guarantee the acquisition of the skills and competences intended.

- **Individual tutorials** as in Scenario 2.

- **Student monitoring**
  As described for on-line teaching in Scenario 2.

X.- EVALUATION

The procedure to follow for the programmed exams (see Scenario 1) is described as follows:

EVALUATION PROTOCOL DESCRIPTION

- **Student identification:**
  A "basic level" identification will be performed by using a user – password authentication procedure.

- **Type of exam:**
  The exam is based on a **questionnaire** (one or several) in the Virtual Campus, which might include questions in which students must upload files. After the exam, personal interviews with randomly selected students will be carried out for students to comment on their answers to the questionnaire. Students with connectivity problems during the exam will be asked to either repeat the questionnaire, or undergo an oral exam/personal interview. Students will be offered a

simulation of the exam fixing a date and time previous to the official one, so they can adjust their equipment properly.

- **Monitoring of students during the test:**
  Those students with adequate devices will be monitored at an "advanced level" using *Google Meet*. If this is not possible, monitoring will be carried out at a "basic level" by controlling the records of activity in the Virtual Campus. After the exam, "basic level" students will be randomly sampled to question them about the exam using video or audio conference. The attendance to the interviews is compulsory for students. The failure to comply with attendance implies a failure in the monitoring of the student during the test, and thus the online exam will not be evaluated.

- **Planned on-line revision mechanism:**
  There will be an on-line and synchronous revision of the test. Students will be requested to notify their willingness to attend the revision so as to assign time slots to each of them. The teacher might require the student to revise and discuss his/her exam in the time allotted for revision, and that will be notified by the CV.

- **Mechanisms to document/record the test for later visualization and evidence:**

The teacher will keep the files (in the format specified by him/her) sent by students with their exams, with the partial marks the teacher deems convenient. In addition, the test can be recorded following UCM's limitations for future reference, if the teacher considers it necessary. Such recording, if performed, will be stored at UCM with the security means deemed necessary, and will be removed after the revision of the test. Moreover, for those students having undergone an oral exam instead of the questionnaire (see bullet point on Type of exam), the exam will be recorded by means of Google Meet or Teams.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1: Systems of units and vectors	Lectures	1.5	1	1st Week	1st Week
	Problem classes/Tutorials	1.5	1		
2: Kinematics of a particle	Lectures	1.5	1	2nd Week	2nd Week
	Problem classes/Tutorials	1.5	1		
3: Dynamics of a particle. Newton's laws	Lectures	3	1	3rd Week	4th Week
	Problem classes/Tutorials	3	1		
4: Work and energy	Lectures	5	1	5th Week	7th Week
	Problem classes/Tutorials	4	1		
5: Systems of particles I: linear momentum and collisions	Lectures	3	1	8th Week	9th Week
	Problem classes/Tutorials	3	1		
6: Systems of particles II: rotation and angular momentum	Lectures	3	1	10th Week	11th Week
	Problem classes/Tutorials	3	1		
7: Fluids	Lectures	3	1	12ª Week	13ª Week
	Problem classes/Tutorials	3	1		
8: Oscillatory motion	Lectures	1.5	1	14ª Week	14ª Week
	Problem classes/Tutorials	1.5	1		
9: Waves	Lectures	4.5	1	15th Week	17th Week
	Problem classes/Tutorials	4.5	1		

10: Properties of light	Lectures	3	1	18th Week	19th Week
	Problem classes/Tutorials	3	1		
11: Electric field	Lectures	3	1	20th Week	21st Week
	Problem classes/Tutorials	3	1		
12: Electric potential and electrostatic potential energy	Lectures	4.5	1	22nd Week	24th Week
	Problem classes/Tutorials	4.5	1		
13: Electric current and direct-current circuits	Lectures	1.5	1	25th Week	25th Week
	Problem classes/Tutorials	1.5	1		
14: Magnetic field	Lectures	1.5	1	26th Week	26th Week
	Problem classes/Tutorials	1.5	1		
15: Sources of the magnetic field	Lectures	1.5	1	27th Week	27th Week
	Problem classes/Tutorials	1.5	1		
16: Magnetic induction	Lectures	1.5	1	28th Week	28th Week
	Problem classes/Tutorials	1.5	1		

ACTIVITY SUMMARY

Teaching activity	Related competences	Lecturer's activities	Student's activities	Assessment procedure	P	NP	Total
Lectures	CE23-F1, CE24-F1, CE24-F2, CE24-F3, CE25 -F1, CE25-F2	Presentation of theoretical concepts.	Note writing.	Grading written responses to questions related with the theoretical concepts presented.	42	58	100
Seminars / Problem classes	CG7 CE23 CE24 CE25-F1 CE25-F2	Application of the theory to problem solving.	Note writing. Problem solving. Question and doubt raising.	Grading written responses (development and results) to solve practical exercises and numerical problems.	35	25	60
Tutorials / Guided work	CG7, CE23, CE24, CE25-F1, CE25-F2, CT2, CT3	Helping the students to direct their study with explanations and bibliographical recommendations. Formulation and proposal of guided work.	Inquiries to the teacher regarding conceptual and methodological difficulties encountered when studying the subject. Writing individual reports.	Student's participation and evaluation of the work.	7	10,5	17,5
Laboratories	CG12, CG13, CT2, CT3, CT4, CT7	Explanations regarding the experimental and analytical methodology and the presentation of scientific results.	Data acquisition and analysis during laboratory sessions. Writing of reports. Passing specific laboratory exam.	Marking of laboratory reports. Marking of laboratory exam.	12	9	21
Exams	CG7, CT4	Design, control and evaluation of the exam. Grading student.	Training and examination.	Marking the exam.	6	20,5	26,5

P: presential; NP: self-study.