

## Course guide

# 820004 - F1FM - Physics I: Fundamentals of Mechanics

Last modified: 08/08/2024

**Unit in charge:** Barcelona East School of Engineering  
**Teaching unit:** 748 - FIS - Department of Physics.

**Degree:** BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

**Academic year:** 2024    **ECTS Credits:** 6.0    **Languages:** Catalan, Spanish, English

### LECTURER

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**Coordinating lecturer:** MICHELA ROMANINI - LUIS CARLOS PARDO SOTO

**Others:** Primer quadrimestre:  
MARTA ALARCON JORDAN - Grup: M31, Grup: M32, Grup: M33, Grup: M34, Grup: M35  
MURIEL BOTEY CUMELLA - Grup: M81, Grup: M82, Grup: M83, Grup: M84, Grup: M85  
PERE BRUNA ESCUER - Grup: M61, Grup: M62, Grup: M63, Grup: M64, Grup: M65  
GERMINAL CAMPS ANAYA - Grup: M32, Grup: M34, Grup: M51, Grup: M52, Grup: M55, Grup: M61, Grup: M62, Grup: M91, Grup: M92, Grup: M93, Grup: M94, Grup: M95, Grup: T21, Grup: T22, Grup: T23, Grup: T24, Grup: X11, Grup: X13  
MARIA DEL BARRIO CASADO - Grup: M51, Grup: M52, Grup: M53, Grup: M54, Grup: M55  
ADRIÀ GRÀCIA CONDAL - Grup: X11, Grup: X12, Grup: X13, Grup: X14  
ROBERTO MACOVEZ - Grup: M21, Grup: M22, Grup: M23, Grup: M24, Grup: M71, Grup: M72, Grup: M73, Grup: M74, Grup: M75  
LUIS CARLOS PARDO SOTO - Grup: M53, Grup: M54, Grup: T11, Grup: T12, Grup: T13, Grup: T14  
TRINITAT PRADELL CARA - Grup: M11, Grup: M12, Grup: M41, Grup: M42, Grup: M43, Grup: M44, Grup: M91, Grup: M92  
MARIA DOLORES RAMIREZ ALBA - Grup: X12, Grup: X14  
MICHELA ROMANINI - Grup: X21, Grup: X22, Grup: X23, Grup: X24  
GLÒRIA SALA CLADELLAS - Grup: M11, Grup: M12  
ALEJANDRO SALVATORI - Grup: T13, Grup: T14, Grup: X21, Grup: X22  
NÚRIA SAU VALENZUELA - Grup: M63, Grup: M64, Grup: M71, Grup: M72, Grup: M73, Grup: M74, Grup: M83, Grup: M84  
MARC SOLA GARCÍA - Grup: M21, Grup: M22, Grup: M31, Grup: M33, Grup: M81, Grup: M82  
TRIFON TODOROV TRIFONOV - Grup: M23, Grup: M24, Grup: T11, Grup: T12, Grup: X23, Grup: X24

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.



**Transversal:**

2. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

**TEACHING METHODOLOGY**

Teaching methodology used: exposition 30%, individual work 60 %, group work 6%, guided activities 4%.

**LEARNING OBJECTIVES OF THE SUBJECT**

Training the student through the acquisition of a working method and providing some knowledge of the principles and basic concepts of Mechanics, so that he/she can apply them to solve problems in the engineering field.

**STUDY LOAD**

Type	Hours	Percentage
Hours small group	9,0	6.00
Hours large group	51,0	34.00
Self study	90,0	60.00

**Total learning time:** 150 h

**CONTENTS**

**Subject 1: Introduction**

**Description:**

Measurement and uncertainty. Graphical analysis and linearization. Vectors.

**Specific objectives:**

Knowing the meaning of the dimensions of a physical magnitude. Knowing the uncertainty associated with experimental measurements and knowing how to calculate the propagation of uncertainty. Learning how to draw graphical representations of experimental data and how to make linear regressions.

**Related activities:**

Laboratory sessions:  
all laboratory session in both terms

**Related competencies :**

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

**Full-or-part-time:** 11h 12m

Theory classes: 3h 24m

Laboratory classes: 1h

Self study : 6h 48m



## Subject 2: Particle kinematics

### Description:

Position, displacement, velocity and acceleration vectors. Motion in one dimension. Motion in two and three dimensions. Circular motion. Simple harmonic motion. Moving frame of reference: Galileo's transformations.

### Specific objectives:

Modeling the motion for a particle, determining the equations of motion from its acceleration and initial conditions. Characterizing the linear and circular motion. Knowing the crucial role of the simple harmonic motion since for its wide application in the study of diverse physical phenomena. Establishing the concept of frame of reference to understand the relative character of the movement.

### Related activities:

Laboratory session:  
Simple pendulum (spring term)

### Related competencies :

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

### Full-or-part-time: 21h 24m

Theory classes: 6h 48m  
Practical classes: 1h  
Self study : 13h 36m

## Subject 3: Particle dynamics

### Description:

Forces in nature. Newton's laws of motion. Linear momentum of a particle. Impulse. Force diagrams. Static equilibrium of a particle. Torques. Static equilibrium of a rigid body. Non-inertial reference frames.

### Specific objectives:

Understanding the concepts of force and mass and knowing Newton's laws of motion. Acquiring the ability to apply the Newton's laws to solve problems that include various particles. Knowing how to establish the conditions for the static equilibrium of a rigid body and solving problems of equilibrium of the rigid body. Knowing the differences between inertial and non-inertial frames of reference.

### Related activities:

Laboratory session:  
Equilibrium forces (spring term)

### Related competencies :

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

### Full-or-part-time: 28h

Theory classes: 9h  
Laboratory classes: 1h  
Self study : 18h



#### Subject 4: Work, energy and power

**Description:**

Work. Power and mechanical efficiency. Work-Kinetic energy theorem. Kinetic energy. Conservative and non conservative forces. Potential energy. Mechanical energy. Work-energy theorem. Conservation of mechanical energy. Energy diagrams in one dimension. Criteria for stable equilibrium.

**Specific objectives:**

Understanding the physical concepts of work, power and energy. Identifying conservative forces and obtaining the corresponding potential energy associated with them. Problem-solving applying the work-kinetic energy theorem work and work-energy theorem. Knowing how to apply the law of conservation of mechanical energy.

**Related activities:**

Laboratory session:  
Pulleys (fall term)

**Related competencies :**

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

**Full-or-part-time:** 11h 12m

Theory classes: 3h 24m

Laboratory classes: 1h

Self study : 6h 48m

#### Subject 5: Dynamics of systems of particles

**Description:**

Systems of particles. Internal and external forces in a system of particles. Center of mass. Linear momentum of a system of particles. Energy of a system of particles. Collisions and explosions. Angular momentum of a particle. Conservation of angular momentum.

**Specific objectives:**

Describing the movement of the center of masses of systems of particles. Knowing to formulate and to apply the principles of conservation of the amount of movement and of the mechanical energy of systems of particles. Applying the theorems of conservation in the study of collisions and explosions.

**Related activities:**

Laboratory session:  
Collisions (fall term)

**Related competencies :**

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

**Full-or-part-time:** 26h

Theory classes: 8h

Laboratory classes: 2h

Self study : 16h



### Subject 6: Planar rigid bodies

**Description:**

Rotation of a rigid body about a fixed axis. Momentum of inertia. Angular momentum of a rigid body. Newton's second law for rotation. Work and power for rotation. Plane kinematics of rigid bodies. Plane dynamics of rigid bodies. Work and energy. System of rigid bodies: conservation of angular momentum.

**Specific objectives:**

Knowing the Newton's second law for rotation and its application to solve problems. Knowing how to characterize the planar motion: coplanar translation and rotation about a fixed axis. Knowing the dynamics of the flat movement and knowing how to apply it to solve problems. Knowing and applying the angular momentum conservation in problem-solving.

**Related activities:**

Laboratory sessions:  
Rotation (spring term)  
Ballistic pendulum (fall term)

**Related competencies :**

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

**Full-or-part-time:** 35h

Theory classes: 11h  
Laboratory classes: 2h  
Self study : 22h

### Subject 7: Oscillations and waves

**Description:**

Mechanical waves. Harmonic waves. Wave equation. Energy, power and intensity of a wave. Superposition of waves: standing waves.

**Specific objectives:**

Identifying the condition for simple harmonic motion in terms of acceleration. Understanding the wave concepts of propagation of energy and momentum. Knowing how to describe harmonic waves. Understanding interference phenomena, in particular, standing waves.

**Related activities:**

Laboratory sessions:  
Standing waves on strings (fall term)  
Sound waves (spring term)

**Related competencies :**

CEB-02. Understand the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and apply them to engineering problems.

05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

**Full-or-part-time:** 11h 12m

Theory classes: 3h 24m  
Laboratory classes: 1h  
Self study : 6h 48m



## GRADING SYSTEM

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MARK M1:

- Laboratory: 15%
- Test 1: 15%
- Test 2: 20%
- Test 3: 25%
- Problems: 25%

MARK M2:

- Laboratory: 15%
- Test 1: 0%
- Test 2: 25%
- Test 3: 30%
- Problems: 30%

MARK M3:

- Laboratory: 15%
- Test 1: 0%
- Test 2: 0%
- Test 3: 42,5%
- Problems: 42,5%

FINAL GRADE = maximum (M1 ; M2 ; M3)

THERE IS NO REASSESSMENT EXAM

## EXAMINATION RULES.

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Carrying out the laboratory practices and submitting the reports are mandatory to pass the course.

In all exams, students can use a pocket calculator. Besides, a physics formula sheet, available at the Metacurs (Atenea), can be used in the Problems' exam.

## BIBLIOGRAPHY

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### Basic:

- Tipler, Paul A.; Mosca, Gene. Física per a la ciència i la tecnologia [on line]. 6ª ed. Barcelona: Reverté, 2010 [Consultation: 26/05/2020]. Available on: [http://www.ingebook.com/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=6536](http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6536). ISBN 9788429144321.
- Alcaraz i Sendra, Olga; López López, José; López Solanas, Vicente. Física : problemas y ejercicios resueltos. Madrid: Pearson Educación, cop. 2006. ISBN 8420544477.
- Alarcón Jordán, Marta [et al.]. Física : problemes resolts. 3a ed. Barcelona: Edicions UPC, 2000. ISBN 8483012197.

### Complementary:

- Gettys, W. E.; Keller, F. J.; Skove, M. J.. Física para ingeniería y ciencias. 2a ed. México, D.F.: McGraw-Hill, cop. 2005. ISBN 9789701048894.
- Sears, Francis W. [et al.]. Física universitària [on line]. 12ª ed. México D. F.: Pearson Educación, 2009 [Consultation: 29/04/2020]. Available on: [http://www.ingebook.com/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=1273](http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1273). ISBN 9786073221252.
- Serway, Raymond A.; Jewett, John W.. Física. 3a ed. Madrid: International Thomson, cop. 2003. ISBN 8497321685.

## RESOURCES

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### Hyperlink:

- Curso Interactivo de Física en Internet  
<http://www.sc.ehu.es/sbweb/fisica/default.htm> />
- La baldufa: un entorn per a l'aprenentatge de la física.  
<http://baldufa.upc.edu/>