Course guides
250550 - GECFMEDAMB - Environmental Physics

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 748 - FIS - Department of Physics.
Degree: BACHELOR’S DEGREE IN MARINE SCIENCE AND TECHNOLOGY (Syllabus 2018). (Compulsory subject).
Academic year: 2020 ECTS Credits: 6.0 Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: ALBERTO FALQUES SERRA
Others: ALBERTO FALQUES SERRA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13388. To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
13390. Establish a good practice in the integration of common numerical, laboratory and field techniques in the analysis of any problem related to the marine environment.

General:
13380. Develop a professional activity in the field of Marine Sciences and Technologies.
13381. Address in a comprehensive manner the analysis and preservation of the marine environment with sustainability criteria.

TEACHING METHODOLOGY

The course consists of 4 hours per week of classroom activity

2 hours are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

2 hours are devoted to solve practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.
LEARNING OBJECTIVES OF THE SUBJECT

In this course, the basic physical principles that occur in the natural physical environment are reviewed. Emphasis is placed on the concepts of Kinematics (reference systems, relative movement, absolute movement), Dynamics (particles, internal / external forces, center of mass, introduction to continuous media), Work and Energy, Thermodynamics and on Electric Fields and Magnetic.

1.- Educational formation in concepts about Kinematics and Dynamics. Laws of Mechanics, Work and Energy.
2.- Application of concepts related to simple harmonic movement and wave kinematics.
3.- Internalize the concepts of fields, illustrated with elements of electricity and magnetism.

In this course, the basic concepts and principles of Newtonian Mechanics that apply to the natural physical environment and, in particular, to the marine environment are taught and worked on. The concepts of position, velocity, acceleration, inertial reference system, force and torque, inertia, linear and angular momentum, work, energy and resonance are introduced. The description and dynamics of the motion of a particle, a system of particles and a rigid solid are studied. Emphasis is placed on some types of force: friction, elastic and gravitational. Relative motion in rotating systems is studied and applied to the case of the earth. Oscillations in one degree of freedom are studied with an elementary introduction to the case of two degrees of freedom. Finally, a brief introduction is made to dimensional analysis and to the analysis and propagation of experimental errors.

The objective of this course is to state the grounds so that the students can later understand the concepts and foundations of geophysical fluid dynamics, with application to the marine and atmospheric environments. This will allows them to understand the dynamics of currents, oscillations and waves in the sea, atmospheric dynamics, the propagation of dissolved substances, etc. It must also establish the bases to address the motion and resistance to motion of floating bodies, marine energy collectors, structures, etc.

This is one of the subjects where the general but essential foundations of the 5 major areas of Marine Sciences and Technologies (Chemistry, Biology, Physics, Geology and Mathematics) are established as a continuation of the training acquired in high school. But the focus is here on the environment and the education on Marine Sciences and Technology.

STUDY LOAD

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<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>10.00</td>
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<tr>
<td>Guided activities</td>
<td>6,0</td>
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<tr>
<td>Hours large group</td>
<td>30,0</td>
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<tr>
<td>Hours medium group</td>
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<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
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Total learning time: 150 h

CONTENTS

**Vectors**

Description:

Specific objectives:
Establish the basics of vector algebra that will be used throughout the course. Practicing vector operations and handling vector components.

**Full-or-part-time:** 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study: 4h 11m

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Particle kinematics

Description:
Vector of position, trajectory, polar and spherical coordinates. Velocity, arc parameter, acceleration. Tangential and normal accelerations.
Solving problem on the position, velocity and acceleration vectors.
Solving exercises on motion with constant or variable acceleration, circular motion and relative motion. Rope and pulley systems.

Specific objectives:
Learning the quantitative description of the motion of a particle
Practice the quantitative description of a particle motion
Learning the properties of some simple motions that are useful. Knowing the changes of position, velocity and acceleration in a change of reference system (without rotation)
Practice and consolidate the knowledge of some simple motions. Learning the concept of kinematic constraint.

Full-or-part-time: 16h 48m
Theory classes: 4h
Practical classes: 3h
Self study : 9h 48m

Particle dynamics

Description:
Inclined plane problems, circular motion, pulleys. Tension of a rope. Interaction forces between bodies.
Fundamental magnitudes, dimensions, dimensionless parameters. Orders of magnitude, significant figures
Solving more advanced problems of particle dynamics. Problems with friction.

Specific objectives:
Understanding the foundations of Newtonian Dynamics and knowing some types of force.
Getting good insight into the basic concepts of Newtonian Dynamics.
Knowing the various friction forces.
Learning the fundamentals of dimensional analysis.
Consolidate the basic concepts of Newtonian dynamics and apply them to higher level problems.

Full-or-part-time: 21h 36m
Theory classes: 5h
Practical classes: 4h
Self study : 12h 36m
### Work and Energy

**Description:**
Definition and calculation of the work and the power done by a force and kinetic energy. Kinetic energy theorem. Applications. Conservative forces, potential energy and energy conservation. Central forces.

Work and energy application problems.

**Specific objectives:**
Understanding the concepts of work, kinetic energy and power. Kowing the relationships between them and some applications. Understanding the concepts of conservative force, potential energy and total mechanical energy. Assimilating well the concepts of work and energy and learning their application.

**Full-or-part-time:** 12h
- Theory classes: 3h
- Practical classes: 2h
- Self study: 7h

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<tr>
<td><strong>Full-or-part-time:</strong></td>
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<td>Laboratory classes:</td>
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<td>Self study:</td>
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<table>
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<th>Rotating reference frames</th>
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<td><strong>Description:</strong></td>
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**Specific objectives:**
Understand the origin of centrifugal and Coriolis forces. Knowing the effects of the rotation of the Earth that are important in Oceanography and Meteorology. Insightful understanding of the effects of the Earth's rotation.

**Full-or-part-time:** 14h 23m
- Theory classes: 4h
- Practical classes: 2h
- Self study: 8h 23m
Rigid Body Kinematics

Description:
Velocity field, acceleration field. Instantaneous center of rotation
Problems finding the angular velocity and velocity field from the velocity of some points. Application of the concept of instantaneous center of rotation.

Specific objectives:
Studying rigid bodies as the first case of continuous medium and their velocity field as an example of a vector field.
Understanding the possible motions of a rigid solid and the concepts of angular velocity and acceleration.
Understanding the basics of 2D motion of rigid bodies.

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study: 4h 11m

Dynamics of particle systems

Description:
Dynamics of the center of mass, linear momentum, impulse theorem. Percussive forces. Open systems
Problems that can be solved by linear momentum balance/conservation.
Applications of angular momentum and energy for simple particle systems. Satellite orbit problems.

Specific objectives:
Assimilating the basis of the dynamics of particle systems and, in particular, of continuous media. Understanding and knowing how to apply the laws of balance of linear momentum, angular momentum and kinetic energy. Understanding the concept of percussive force
Assimilating the concept of linear momentum and learning the application of the law of balance/conservation
Understanding angular momentum as a quantity analogous to linear momentum for rotational motion. Knowing the general laws of the motion of a particle system.
Understanding the angular momentum concept and its role in the dynamics of rotational motions. Learning how to apply the energy methods to the dynamics of particle systems.Learning how to apply all this knowledge to the case of satellite orbits.

Full-or-part-time: 16h 48m
Theory classes: 4h
Practical classes: 3h
Self study: 9h 48m
Rigid Body Dynamics

Description:
Angular momentum, dynamics of 2D rotation and moment of inertia. Kinetic energy and potential energy of a rigid solid.
Problems of translation and rotation motion of one or more rigid bodies. Calculation of some moments of inertia.
Equilibrium conditions. Problems of Statics and imminent movement. Solid systems.

Specific objectives:
Learning the laws of 2D motion of a rigid solid. Knowing how to apply energy analysis to the motion of rigid bodies.
Learning to apply the laws of motion of a rigid solid. Learning to calculate moments of inertia
Learning to analyze the equilibrium conditions of a rigid body or a system of rigid bodies, and to calculate the forces involved.
Same as session 26. Learning to apply the laws of statics to a rigid body or body system.

Full-or-part-time: 16h 48m
Theory classes: 3h
Practical classes: 4h
Self study : 9h 48m

Oscillators

Description:
Harmonic oscillator and simple harmonic movement. Damping caused by a friction proportional to the speed. Harmonic forcing.
Concept of resonance, resonance frequency and quality factor. Linearization of the equation of a nonlinear oscillator, stability of
the equilibrium and small oscillations. Normal oscillation modes for 2 freedom degree systems.
Harmonic and damped oscillator problems. Resonance problems. Problems of determining the frequency of small oscillations for
some nonlinear oscillator.
Different types of errors. Errors in indirect measurements and error propagation. Rounding and significant figures. Plotting
experimental data. Linear regression line.
First the constant of a spring is measured by applying different loads. Then the oscillation period of various masses hanging from
the spring is measured. From here another measure of the elastic constant is obtained.

Specific objectives:
Knowing the properties of oscillatory motion caused by a linear restoring force. Knowing the characteristics of the damped
oscillations. Knowing the response of the damped oscillator to an external force.
Understanding the concept of resonance. Understanding the concept of stability of equilibrium and small oscillations around
equilibrium. Learning to linearize in simple cases. Understanding the concept of normal mode.
Knowing the characteristics of oscillatory motions and understanding the concept of resonance. Understanding the concept of
stable equilibrium and small oscillations around it. Learning to linearize the equations of motion of nonlinear oscillators in simple
cases.
Learning the concept of error in measurements and the different error sources. Knowing how errors propagate in the
computations. Learning to appropriately round the results of measurements or calculations.
Experimentally check Hooke’s Law and work with the period of an oscillation. See, at least once, how a physical magnitude is
measured by acquiring experimental data and processing them.

Full-or-part-time: 21h 36m
Theory classes: 5h
Practical classes: 2h
Laboratory classes: 2h
Self study : 12h 36m
GRADING SYSTEM

The qualification of the course is obtained from the qualifications of continuous assessment and the corresponding laboratory and / or computer classroom.

The continuous evaluation consists of doing different activities, both individual and group, of an additive and formative nature, made during the course (inside the classroom and outside of it).

Continuous assessment:
- Exercises in class and Lab practice report: 10%
- Parcial 1: 15% (Without form, with calculator)
- Parcial 2: 15% (Without form, with calculator)
- Final examination: 60% Test without form, and problems with "official" form (will be loaded in Athena) and calculator.

The course grade is obtained as the geometric mean of the scores of the continuous assessment exercises (30% of tests in class and 10% of exercises and deliverables) and of the final exam (60%)

EXAMINATION RULES.

Failure to appear for any of the tests implies a grade of zero in that test. Exams are strictly individual. Failure to comply with this rule in an exam may result in a grade of zero.

BIBLIOGRAPHY

Basic:

Complementary: