Environmental Physics (250550)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	6.0 ECTS
Programs	GRAU EN CIÈNCIES I TECNOLOGIES DEL MAR (pla 2018)
Course	2024/25

Main teaching language at each group

- Group 11 Catalan (Q1)
- Group 12 Catalan (Q1)

Faculty

Responsible Faculty: Alberto Falques Serra
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Objectives of Education

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.

IIn 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.

Competencies

Especific

To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
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.

Generic

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

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	30.0 h	50.00 %
	Medium group	15.0 h	25.00 %
	Laboratory classes	15.0 h	25.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		90.0 h	

Contents

Vectors

Vector algebra, Cartesian bases and components. Dot product, vector product, mixed product and double vector product
Exercises of operations with vectors

Specific Objectives

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

Particle kinematics

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.
Uniformly accelerated motion, circular motion, angular velocity vector. Coordinate axis translation.
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.

Particle dynamics

Newton's laws. Inertial systems and inertia forces. Gravitational force. Contact forces. Elastic force.
Inclined plane problems, circular motion, pulleys. Tension of a rope. Interaction forces between bodies.
Dry friction. Solid-fluid friction. Viscosity in a fluid. Introduction to the dimensional analysis.
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.
Consolidate the basic concepts of Newtonian dynamics and apply them to higher level problems.

Work and Energy

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.

Evaluation

Rotating reference frames

Rotating coordinate frames. Velocity and acceleration transformation. Centrifugal and Coriolis forces.
Perturbation of gravity due to centrifugal force. Effect on the tides. Effects of Coriolis force: cyclones and anticyclones. Projectile deflection.
Problems of relative motion of satellites, projectiles and vehicles.

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.

Rigid Body Kinematics

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.

Dynamics of particle systems

Dynamics of the center of mass, linear momentum, impulse theorem. Percussive forces. Open systems
Problems that can be solved by linear momentum balance/conservation.
Definition of angular momentum and law of balance. Angular momentum. Kinetic energy and potential energy of a particle system. Applications.
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.

Rigid Body Dynamics

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.
Complement session 26. Problems of statics.

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.

Activities

Practical project on measurements and errors

Practical assignement in the lab

Objectives

Experimental data management and errors on the measurements

Material

Lab material, instructions and sheet to fill in with the experimental results.

Dedication

2h

Experiment on the Hooke's Law

Checking Hooke's law, measurement of the elastic constant and oscillations

Material

Lab material, instructions and form to be filled in with the results

Dedication

2h

Teaching Methodology

The course consists of 4 hours a week of classroom classes:

a) Theory: 2 hours are devoted to theoretical classes in which the teacher presents the concepts and basic materials of the subject and presents examples. Whenever possible, concepts and laws are introduced from particular cases and the general formulation is then presented. The examples are intended to be related to the marine environment: Presentation is combined with ppt and use of the blackboard, and when appropriate, a video is projected.
b) Problems: 2 hours are devoted to completing the theory with examples and to solving problems with greater interaction with students. Efforts are also made to ensure that problems are as closely related to the marine environment as possible.

There is also two practical projects that are carried out in the Physics Laboratory of the Campus Nord with 4 hours duration.

There is also to practical projects to be developped at the Physics Lab

Support material in digital format which is available on the ATENEA virtual campus is used: the theory ppt's, a collection of problems with their result, the description of the laboratory project and links to Internet sites that can be useful.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The final grade of the course is obtained according to the following partial marks:
1) First partial exam (P1)
2) Second partial exam (P2)
3) Final exam (F)
4) Laboratory (L1)
5) Exercise based on the laboratory work (L2)
6) Classroom grade (C)

There are two ways to pass the course:
a) Continuous evaluation
b) Final exam.

The marks corresponding to each option are computed as:
Na=0.3*P1+0.4*P2+0.1*L1+0.1*L2+0.1*C
Nb=0.9*F+0.1*L1

The second and the final exams will take place at the same time and some of the exercises are shared between both exams. The students freely choose the exercises they want and they get two marks: according to option a) and according to option b). The resulting grade is the highest out of both.

- All the marks are out of 10.
- The grade "Not presented" is obtained in case the student has not done any exam or gradable activity.

RE-EVALUATION: those students who do not pass with any of both options (a,b) can do a re-evaluation exam if they have done the practical laboratory work.

Test 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.

Office Hours

- Agreed hours: albert.falques@upc.edu
- The preferred timetable will be communicated at the beginning of the course

Bibliography

Basic

- Bedford,A.; Fowler, W. Mecánica para Ingeniería - Dinámica. 5a ed. Naulcalpan de Juárez, Mexic: Pearson Educación, 2008. ISBN 9786074428759.

Complementary

- Tipler, P.A.; Mosca, G. Física para la ciencia y la tecnología. 6a ed. Barcelona: Reverté, 2010. ISBN 9788429144284 (O.C.).
- Sears, F.; Zemansky, M.; Young, H.; Freedman, R. Física universitaria. 13 ed. Pearson Consumo, 2014. ISBN 9786073221245 (VOL. 1) ; 9786073221900 (VOL. 2).