



(*)Facultade de Ciencias do Mar

Grado en Ciencias del Mar

Subjects

Year 3rd

Code	Name	Quadmester	Total Cr.
V10G061V01301	Biological oceanography I	1st	6
V10G061V01302	Physical oceanography I	1st	6
V10G061V01303	Geological oceanography I	1st	6
V10G061V01304	Chemistry applied to the marine environment I	1st	6
V10G061V01305	Physiology of marine organisms	1st	6
V10G061V01306	Biological oceanography II	2nd	6
V10G061V01307	Physical oceanography II	2nd	6
V10G061V01308	Geological oceanography II	2nd	6
V10G061V01309	Chemistry applied to the marine environment II	2nd	6
V10G061V01310	Aquaculture	2nd	6

IDENTIFYING DATA				
Biological oceanography I				
Subject	Biological oceanography I			
Code	V10G061V01301			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Galician			
Department				
Coordinator	Lastra Valdor, Mariano			
Lecturers	Aranguren Gassis, María Lastra Valdor, Mariano			
E-mail	mlastra@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	This subject insight in the study of a number of coastal ecosystems, located in the sea-land interface, from a ecological approach. This includes beaches, rocky shore, saltmarshes, estuaries, seagrass, coastal lagoons, dunes, reefs and mangroves. The fundamental aim will be to understand the ecosystem functions, to analyze faunal assemblages and to describe the human impact that these environments face in an scenario of global change.			
	English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B2	Plan and execute surveys in the field and laboratory work, applying basic tools and techniques for sampling, data acquisition and analysis in the water column, sea bottom and marine substratum.
B3	Recognize and implement good practices in measurement and experimentation, and work responsibly and safely both in field surveys and in the laboratory.
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.
B5	Develop, implement and write basic or applied projects in oceanography from a multidisciplinary perspective.
C1	know at a general level the fundamental principles of sciences: Mathematics, Physics, Chemistry, Biology and Geology.
C9	Acquire basic knowledge about the structural and functional organization and the evolution of marine organisms.
C10	Know the biological diversity and functioning of marine ecosystems.
C11	Apply the knowledge and techniques acquired to the characterization and sustainable use of living resources and marine ecosystems.
D2	Acquire the ability to learn autonomously, continuously and collaboratively, organizing and planning tasks over time.
D3	Understanding the meaning and application of the gender perspective in different fields of knowledge and in professional practice with the aim of achieving a more just and equal society.
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Through theoretical contents, practical, exits of field and the work of investigation, at the end of the course the student will have to have purchased the necessary knowledges that allow him interpret the operation of the coastal ecosystems (estuaries, beaches, coastal lagoons, etc), and his interaction with the antropic activities in the open ocean.	A3 B2 C1 D2
	A4 B3 C9 D3
	A5 B4 C10 D5
	B5 C11

Contents	
Topic	
1. Estuaries	1.1. Introduction 1.2. Salinity and substrate 1.3. Vegetation and macrofauna 1.4. The communities of Petersen 1.5. The alimentary chain

3. Rocks	2.1. General appearances 2.2 Adaptations to the physical stress: temperature, waves, burial, .. 2.3. Coasts warmed up, exposed and moderately exposed. 2.4. Subtidal rocks 2.5. Control factors 2.6. The food chain
4. Beaches	3.1. Introduction 3.2. Types of Beaches 3.3. Zonation 3.4. Flora and fauna
5. Coastal lagoons	4.1. General characteristics 4.2. Lagoon organisms 4.3. Ecology of the coastal lagoons 4.4. Primary and secondary production
6. Dune systems	5.1. General characteristics 5.2. Characteristics of ecological importance 5.3. Dune vegetation 5.4. Fauna 5.5. Food chains
7. Mangroves	6.1. Distribution and physical conditions 6.2. Zonation 6.3. Ecological importance
8. Coral reefs	7.1. The paper of the zooxanthellae 7.2. Factors that limit the growth of the reefs 7.3. Geographic distribution and types of coral reefs 7.4. Productivity of the reef 7.5. Biological interactions and mutualism
9. Vertical structure in open ocean and coastal waters: biology of the superficial ocean.	8.1 Zonation of the oceanic region 8.2. Phytoplankton and zooplankton 8.3. Food webs

Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	7	7	14
Laboratory practical	15	0	15
Studies excursion	0	10	10
Lecturing	25	37.5	62.5
Mentored work	0	34.5	34.5
Objective questions exam	1	10	11
Essay	1	2	3

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Seminars	They will divide the groups in subgroups of 3-4 people. Each subgroup will prepare a work to choose between the subjects offered by the professor at the beginning of the course. Each student will have to involve clearly in all or some of the facets of the work. The works will be directed during the destined hours to the seminars. The oral exhibition will have a length of 20 minutes for the oral presentation and 5 minutes for the round of questions of the professor and of the rest of students. The presentation will come accompanied by an archive in computer support (PDF) that will send to the professor in dates fixed previously to the presentation.
Laboratory practical	With the samples taken during the field trip to the sea, the students will learn the separation, identification and headcounts of pertaining organisms to distinct groups of the benthos. With the table of data obtained will work the statistical section from univariate analysis, bivariate and multivariate.
Studies excursion	They will conduct in the subject two field trips: 1) Sail along the the estuary of Vigo in the ship Mytilus, for the collecting benthic samples with quantitative dredges (Van-Veen). 2) Field trip to Aguiño (Ribeira, A Coruña)
Lecturing	They will present and they will argue theoretical contents that they will be evaluated in a final examination.
Mentored work	The works of investigation will be driving in group through the seminars. The students that belong to the same group will have to assist to same group of seminar.

Personalized assistance	
Methodologies	Description
Lecturing	Theoretical classes on the subjects of the subject. Its content will be moved to the platform TEMA once that each subject has been finalised. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation. Schedule of tutorials: Tuesday and Thursday of 17:00 to 18:00 h.
Laboratory practical	3 groups of laboratory of 20 students roughly.
Seminars	3 groups of seminars, of roughly 15 students, and that will serve to give support to the works of investigation developed by the students.

Assessment				
	Description	Qualification	Training and Learning Results	
Seminars	They will divide the groups in subgroups of 3-4 people. Each group will prepare a scientific work chosen from among the proposed by the own students or by the professor at the beginning of the course. The works will be supported during the destined hours to the seminars (small groups 2.5h). The exhibition of the works will take place in the date established in the calendar of the Faculty, and will have a length of 20 minutes for the oral presentation and 5 minutes for the round of questions of the professor and of the rest of students. The presentation will come accompanied by an archive in computer support (*powerpoint) as well as an archive in PDF that will send to the professor in dates fixed in the calendar of *entregables of the Faculty.	30	A3 B2 C1 D2 A4 B3 C9 D3 A5 B4 C10 D5 B5 C11	
Laboratory practical	The practical assistance of laboratory and to the field excursions will be mandatory. Will have to deliver a fascicle of practices (maximum 1500 words) in which they appear reflected the tasks, results and observations so much of the practices of laboratory as of the exits of field. It will evaluate the participation in the practices, the rigour in the work of sampling and laboratory, the aptitude for the work in team and the capacity to elaborate and interpret results.	30	A3 B2 C1 A4 B3 C9 A5 B4 C10 B5 C11	
Lecturing	Examination written. They will make questions that show the level of understanding purchased by the students to the long of the matter, so much in the theoretical classes, as practical, seminars and field work.	40	A3 B2 C1 D2 A4 B3 C9 D3 A5 B4 C10 D5 B5 C11	

Other comments on the Evaluation

To pass the subject it is necessary to pass each of the three tests (master sessions, research work and laboratory practices).

In the second call, there will be a written exam corresponding to the subject taught and the criteria established in the REGULATION ON ASSESSMENT, QUALIFICATION AND TEACHING QUALITY AND THE STUDENT LEARNING PROCESS of the University of Vigo will be followed.

The date, time and place of the evaluation tests, presentations and deliverables will be published on the official website of the Faculty of Marine Sciences: <http://mar.uvigo.es/alumnado/examenes/>

Students who take this subject are required to behave responsibly and honestly. Any form of fraud (copying or plagiarism) aimed at distorting the level of knowledge and skills achieved in any type of test, report or work is considered inadmissible. Fraudulent conduct may mean failing the subject for a full course. will keep an internal record of these actions so that, in case of recidivism, request the opening of a disciplinary file to the rector.

- **Global assessment option:** The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start. Given the experimental nature of the practices, attendance at them is mandatory to be eligible for this evaluation option. **Failure to attend the practices, with no justified cause invalidates this possibility, as well as the opportunity for extraordinary evaluation (2nd opportunity).**

Sources of information

Basic Bibliography

- Moore P.G. & R. Seed, **The ecology of Rocky coast**, First Edition, Columbia University Press, 1986
- Keninich Michael J., **Coastal Lagoons: Critical habitats of Environmental Change**, First Edition, CRC Press Taylor and Francis Group, 2010
- Hogarth Peter J., **The Biology of Mangroves**, First Edition, Oxford University Press, 1999
- Kjerfve B., **Coastal Lagoon processes**, First Edition, Elsevier science B.V., 1994
- Sorokin Y. I., **Coral Reef Ecology**, Springer, 1995
- Barnes R.S.K., **An introduction to marine ecology**, Second edition, Blackwell Science, 1999
- Nordstrom, K.F., Psuty, N. & Carter, B., **Coastal dunes**, Wiley & sons, 1990
- Nybakken, James W., **Marine biology : an ecological approach**, Fourth edition, Pearson Benjamin Cummings, 2005
- Brown, A.C. & McLachlan, **Ecology of sandy shores**, Elsevier, 1990

Complementary Bibliography

- Knox G.A., **The ecology of seashores**, CRC Press, 2001
- D. Bertness et al, **Marine community ecology and conservation**, Second edition, Sunderland, Massachusetts : Sinauer Associates, 2014
- Levinton J.S., **Marine Biology: function, biodiversity, ecology**, Oxford University Press, 2001
- Rupert F.G. Ormond, John D. Gage, and Martin V. Angel, **Marine biodiversity : patterns and processes**, First Edition, Cambridge University Press, 1997
- Raffaelli D.G., **Intertidal ecology**, Second edition, Chapman & Hall, 1999
- Little, C. & Kitching, J.A, **The Biology of rocky shores**, Second edition, Oxford University, 2009
- Adam, P., **Saltmarsh ecology**, Cambridge University press, 2010
- Barreiro F., Gómez M., López J., Lastra M. & la Huz R., **Coupling between macroalgal inputs and nutrients outcrop in exposed sandy beaches**, Hydrobiologia, 700: 73-84, 2013
- Vila-Concejo A. & Kench P.S., **Storms in Coral Reefs: Processes and Impacts**, Coastal Storms, pp.127-149, 2017
- Ansell, A.D, Gibson, R.N., Barnes, M.,, **Oceanography and Marine Biology, An annual review**, Aberdeen University Press, 1995
- Shing Yip Lee et al., **Ecological role and services of tropical mangrove ecosystems: a reassessment**, Global Ecology and Biogeography 23 , 726-743, 2014

Recommendations

Subjects that continue the syllabus

Biological oceanography II/V10G061V01306

Subjects that are recommended to be taken simultaneously

Physiology of marine organisms/V10G061V01305

Geological oceanography I/V10G061V01303

Subjects that it is recommended to have taken before

Biology: Biology I/V10G061V01101

Biology: Biology 2/V10G061V01106

Biochemistry/V10G061V01201

Marine botany/V10G061V01202

Marine zoology/V10G061V01210

IDENTIFYING DATA				
Physical oceanography I				
Subject	Physical oceanography I			
Code	V10G061V01302			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Roson Porto, Gabriel			
Lecturers	Roson Porto, Gabriel Sánchez Carnero, Noela Belén			
E-mail	groson@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	Knowledge of the main physical processes in the ocean as well as their relevant climatological causes. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.
C3	Describe how works the global ocean circulation, its forcings and its climate implications.
C4	Know, analyze and interpret the physical properties of the ocean according to current theories, as well as to know the most relevant sampling tools and techniques.
C5	Formulate the mass, energy and moment conservation equations for geophysical fluids and solve them in basic oceanic processes.
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Basic knowledge of the climatological processes and the meteorological phenomena, with special attention to his influence on the oceanic processes.	A5	B1	C3 C5	D1
Descriptive knowledge of the main physical processes in the ocean			C3 C4	D1
Descriptive knowledge of the oceanic circulatory systems.		B1	C3 C4 C5	D1

Contents

Topic	
I. BASIC CLIMATOLOGY	<p>I.1. Description of the atmosphere: composition, temperature and density with height.</p> <p>I.2. Electromagnetic radiation. Black body emission. Characteristics of solar and terrestrial radiation.</p> <p>I.3. Radiative budget. Albedo and absorption. The greenhouse effect. Energetic latitudinal disequilibrium of the Earth. General movements of air masses, planetary convective cells.</p> <p>I.2. Fundamentals of Meteorology: atmospheric pressure; vertical and horizontal structure. Surface maps: isobaric systems. Accelerations in isobaric systems; geostrophic equilibrium; horizontal and vertical circulation.</p>

II. HYDROGRPHY AND WATER MASSES

II.1. TEMPERATURE

II.1.1. Surface distribution.

II.1.2. Temperature of the water column. Differences among three regions: Mixing layer, seasonal thermocline, main thermocline, deep waters.

II.1.3. Upwelling. Ekman spiral. Ekman Transport. Types of upwelling. Downwelling.

II.2. SALINITY

II.2.1. Conservative and no conservative components. Absolute and practical salinity.

II.2.2. Surface distribution and its relationship with balance precipitation + runoff - evaporation. Estuaries and estuarine circulation. Coupling estuarine circulation with upwelling and downwelling.

II.3. MASAS DE AGUA Y DIAGRAMAS TS

II.3.1. Water masses and water types. Abyssal circulation. Types of density variation in relation with water masses formation. The core method.

Identification of water masses circulation.

II.3.2. Equation of state of Seawater. Isopycnals. Density vertical profiles of by latitudes: The pycnocline. Density gradient and water masses stability.

II.3.3. TS diagrams. Mixing of water types; caballing. Stability of water masses using TS diagrams.

III. DYNAMICS OF OCEAN CURRENTS

III.1. Surface currents and wind systems. The westward intensification. Eulerian and lagrangian currents.

III.2. The subtropical and subpolar gyres. Equatorial currents. The Antarctic Circumpolar Current.

III.3. Dynamic topography and geostrophic currents. Barotropic and baroclinic regimes. Helland-Hansen equation.

III.4. Origin of the dynamic topography: cyclonic and anticyclonic winds. Convergences and divergences of the surface currents. Relationship with upwelling and downwelling. Ekman Pumping.

IV. REGIONAL OCEANOGRAPHY

IV.1. THE ANTARCTIC OCEAN.

IV.2. THE ATLANTIC OCEAN.

IV.3. THE MEDITERRANEAN SEA.

IV.4. THE PACIFIC OCEAN.

IV.5. THE INDIAN OCEAN.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	36	0	36
Seminars	16	8	24
Autonomous problem solving	0	46	46
Objective questions exam	1	3	4
Problem and/or exercise solving	0	20	20
Essay questions exam	4	16	20

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Theoretical lessons
Seminars	Research work (obligatory attendance)
Autonomous problem solving	Exam

Personalized assistance

Methodologies	Description
Lecturing	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation, only via institutional account @alumnos.uvigo.es. Monday-Tuesday-Wednesday 10-12 h.
Seminars	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation, only via institutional account @alumnos.uvigo.es. Monday-Tuesday-Wednesday 10-12 h.

Autonomous problem solving	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation, only via institutional account @alumnos.uvigo.es. Monday-Tuesday-Wednesday 10-12 h.
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Tests	Description
Objective questions exam	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation, only via institutional account @alumnos.uvigo.es. Monday-Tuesday-Wednesday 10-12 h.
Problem and/or exercise solving	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation, only via institutional account @alumnos.uvigo.es. Monday-Tuesday-Wednesday 10-12 h.
Essay questions exam	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation, only via institutional account @alumnos.uvigo.es. Monday-Tuesday-Wednesday 10-12 h.

Assessment					
	Description	Qualification	Training and Learning Results		
Objective questions exam	It is part of the official examination	20			C3
Problem and/or exercise solving	Deliverable questions in seminars	40	B1		C4
Essay questions exam	Official exam	40	A5	B1	C5 D1

Other comments on the Evaluation

Every report must be filed no later than 7 days after the seminar, and none will be evaluated if sent after that timeframe and the grade will be 0.

When a student files his/her report his status in this subject will change to presented.

The final grade of the subject will be the sum of 40% of the final (official) test (ot), 40% of an intermediate test (ie), and a 20% from the seminars test (st), according to the formula:

$$N=0.4*ot+0.2*ie+0.4*st$$

The grade in the official test must be at least 5 (from 0 to 10).

CONTINUOUS EVALUATION of the education in the classroom:

Intermediate test half course (1 hour, 40% divided between 20% problems and 20% objective questions). The test will take place during the theoretical classes, and be part of the faculty's test's schedule.

SEMINARS' CONTINUOUS EVALUATION.

Seminars' individual report's (20%). The students must assist to the seminars, and do the reports again, the following, year if they don't pass the subject.

The seminars and partial test qualification's will be saved for the second opportunity.

Final oficial test (3 hours, 40%).

GLOBAL EVALUATION PROCEDURE: For the students choosing this modality, there will be a global oral evaluation test, in the language chosen by the student, the same day of the official test according to the faculty's schedule. This test will be public and the audio and video will be recorded. The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start.

Students are strongly requested to fulfil a honest and responsible behaviour. It is considered completely unacceptable any alteration or fraud (i.e., copy or plagiarism) contributing to modify the level of knowledge and abilities acquired in exams, evaluations, reports or any kind of teacher's proposed work. Fraudulent behaviour may cause failing the course for a whole academic year. An internal dossier of these activities will be built and, when reoffending, the university rectorate will be asked to open a disciplinary record.

The tests' classroom, date and time will be published at the Marine Sciences' website:

<http://mar.uvigo.es/alumnado/examenos/>

Sources of information

Basic Bibliography

SENDIÑA, I Y . PÉREZ MUÑOZURI, V, **Fundamentos de meteorología**, Universidad de Santiago de Compostela, Servizo de Publicacións e Intercambio Científico,

R.A. Varela y G. Rosón., **Métodos en Oceanografía Física**, Editorial Anthias Biblioteca INNOVA,

Complementary Bibliography

PICKARD, G.L. y W. EMERY, **Descriptive Physical Oceanography**, 6ª edition. Pergamon Press.320 p.,

TOMCZAK, M. y J. STUART GODFREY, **Regional Oceanography: an introduction**, Pergamon. 422 p.,
<http://www.es.flinders.edu.au/~mattom/regoc/pdfver>,

ANGELA COULING and the Open University course Team., **Ocean circulation**, Pergamon press, 238 p.,

R. STEWART, **Introduction to Physical Oceanography**, Texas A&M University.,

<http://www.uv.es/hegigui/Kasper/por%20Robert%20H%2>,

Recommendations

Subjects that continue the syllabus

Physical oceanography II/V10G061V01307

Subjects that it is recommended to have taken before

Physics: Physics I/V10G061V01102

Mathematics: Mathematics I/V10G061V01104

Mathematics: Mathematics II/V10G061V01109

Physics: Physics II/V10G061V01203

Other comments

IMPORTANT MARKS:

The delivery of the individual seminar report for teacher assessment has a deadline of 7 days after the day when seminar took place. After that deadline no reports will be collected. In this circumstance, mark will be 0.

The delivery of any report by the student for teacher assessment implies student goes to PRESENTED mode automatically, regardless of the student sit for final exam.

The final mark of this matter will be an average of three marks (between 0 and 10): the partial exam (pe), the official exam (oe) and the average mark of the seminars, both in first and second opportunity, accordingly with: (se)

$$n = 0,2*pe + 0,4*oe + 0,4*se$$

The official exam as well as average mark of the seminars must be passed separately.

Repeat students should attend and deliver again seminars.

IDENTIFYING DATA				
Geological oceanography I				
Subject	Geological oceanography I			
Code	V10G061V01303			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Bernabéu Tello, Ana María			
Lecturers	Alejo Flores, Irene Bernabéu Tello, Ana María Fontán Bouzas, Ángela			
E-mail	bernabeu@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	<p>Geological oceanography (also called marine geology) is one of the broadest fields in the Earth Sciences and contains many subdisciplines, including geophysics, and plate tectonics, petrology and geochemistry, sedimentation processes, and micropaleontology and stratigraphy. Geological Oceanography I will focus on the study of basic earth processes affecting sedimentation in litoral areas, since sediments are the main geological feature of these region. The subject will cover the fundamental techniques to study the topography, structure, sedimentation, and associated geological processes of these areas to discover how they were formed and how ongoing processes (coastal dynamics, climate change, human impact...) may change them in the future. The subject will deal with the peculiarity of combining terrestrial and marine data to study litoral and coastal processes.</p> <p>English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.</p>			

Training and Learning Results				
Code				
A1	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study			
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study			
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues			
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy			
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.			
B2	Plan and execute surveys in the field and laboratory work, applying basic tools and techniques for sampling, data acquisition and analysis in the water column, sea bottom and marine substratum.			
B5	Develop, implement and write basic or applied projects in oceanography from a multidisciplinary perspective.			
C12	Acquire knowledge about processes and products related to internal and external geological cycles.			
C13	Acquire the basic sedimentological, geochemical and geophysical techniques and methodologies used in identification, use and sustainability of the natural resources of coastal and marine environments.			
C14	Know basic concepts and events of global change obtained from geological records.			
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.			
D2	Acquire the ability to learn autonomously, continuously and collaboratively, organizing and planning tasks over time.			
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.			

Expected results from this subject				
Expected results from this subject	Training and Learning Results			
Ability to plan and execute field campaigns on the coast and coastline.	A5	B2	C13	D1 D5
Manage the techniques of observation, measurement, recognition and description of marine sedimentary elements and materials in these environments.	A1 A5	B1	C12 C13	D1
Manage sampling and prospecting techniques.	A2 A5	B2	C12 C14	D1

Handle sediment characterization and analysis techniques.	A1 A2 A5	B1 B2	C12 C13	D1 D2
Geological mapping and representation capabilities	A2 A3	B1	C12 C13	D2
Ability to prepare and present reports	A3 A5	B1 B5	C14	D1

Contents

Topic	
T0 Presentation	0.1 Aims 0.2 Activities 0.3 Program 0.4 System of qualification
T1 Introduction	1.1 History and development of the Geological Oceanography 1.2 Importance of the Geological Oceanography
T2 General protocol for the geological investigation in coastal area	2.1. Nature of the research and of the projects in marine geology 2.2. General protocol for design and execution of a project 2.3. Approach and definition of methodological strategies 2.4. Evaluation, interpretation and publication of data
T3 Coastal morphodynamics	3.1 Basic concepts 3.2 Influence of the swell, the tide and the sedimentary characteristics 3.3 Morphodynamics evolution of the systems of beach
T4 Introduction to the positioning systems	4.1 Importance of the positioning in the acquisition of data 4.2 Basic concepts in geodesy: geoid, ellipsoid and datum 4.3 Global system of navigation by satellite (GNSS) 4.4 Sources of error in the measures of positioning 4.5 GPS: Methods of measure
T5 Methods of sampling and subsampling	5.1 Determination of sampling objectives, strategy and equipment selection 5.2 Sampling in subtidal area: techniques and strategy 5.3 Sampling in sea: Sediment of the bottom Sediment in the water column 5.4 Protocol for processing of samples in laboratory 5.5 Cataloging, archive and conservation
T6 Advanced methods of characterisation of the sediment SEMINAR 1: Physical properties of the sediment	- Density gamma and gamma natural - Resistivity and poropermeability - Susceptibility and other magnetic properties - Photos and colour - X-rays - Corescanners: *GEOTEK and 2G
T6 Advanced methods of characterisation of the sediment SEMINAR 2: Compositional analysis	- Elementary analysis: LECO, ICP, FRX - Mineralogical analysis: DRX - Corescanners: ITRAX and AVAATEC
T6 Advanced methods of characterisation of the sediment SEMINAR 3: Electronic microcopy	- Textural study - Compositional analysis
T7 Study of the intertidal and supra tidal zone	7.1 Duality earth-sea 7.2 Topography, teams of measured GPS Lidar 7.3 Study of the subsoil: GPR
T8 Study of the subtidal zone: Acoustic methods	8.1 Foundations of acoustic waves 8.2 Echo sounders 8.3 Side scan sonar 8.4 Processed of data
T9 Subsuperficial study of the subtidal zone: seismic Methods	9.1 Foundations of seismic waves 9.2 Seismic of reflection: Equipments Acquisition of data Processed of a seismic line Interpretation of data

PA1 Planning Campaign	Like designing a project, will make on a real example PA1.1 Definition of aims PA1.2 Selection of methodologies PA1.3 Definition of activities and scope PA1.4 Cronograms PA1.5 Economic calculations
PA2 Field trip	PA2.1 Requirements and basic norms of security in oceanographic boats PA2.2 Conhabitation PA2.3 Manoeuvres and technical of sediment sampling PA2.4 Manoeuvres and technical of geophysical exploration. PA2.5 Management and archive of data

Planning			
	Class hours	Hours outside the classroom	Total hours
Seminars	7	9	16
Field practice	5	5	10
Introductory activities	2	4	6
Case studies	15	32	47
Lecturing	23	33	56
Autonomous problem solving	0	15	15

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Seminars	2:20 h long seminars on complementary topics
Field practice	It includes ship minicruises oriented to experience oceanographic work in real conditions
Introductory activities	It comprises the activities carried out during the two first lectures, like subject presentation, time schedule, qualification procedures and other pertinent indications for the course well-being.
Case studies	Preparation of a project in real terms: analysis of the problematic, definition of aims, methodological planning, timing and economic estimate.
Lecturing	Lectures comprising the major topics of the course program
Autonomous problem solving	Throughout the theoretical development of the subject, questions and problems related to the contents covered will be raised that the student must solve autonomously.

Personalized assistance	
Methodologies	Description
Lecturing	The tutorials will take place preferably on Monday and Thursday from 12:00 to 14:00 The tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. In the face-to-face modality, the tutorials will be held in office D42, block C, 3rd floor of the CC Experimental Building, as long as the teacher does not have to attend to other academic obligations. To optimize the time, it is necessary for the student to contact the teacher in advance
Seminars	The tutorials will take place preferably on Monday and Thursday from 12:00 to 14:00 The tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. In the face-to-face modality, the tutorials will be held in office D42, block C, 3rd floor of the CC Experimental Building, as long as the teacher does not have to attend to other academic obligations. To optimize the time, it is necessary for the student to contact the teacher in advance
Field practice	The tutorials will take place preferably on Monday and Thursday from 12:00 to 14:00 The tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. In the face-to-face modality, the tutorials will be held in office D42, block C, 3rd floor of the CC Experimental Building, as long as the teacher does not have to attend to other academic obligations. To optimize the time, it is necessary for the student to contact the teacher in advance
Introductory activities	The tutorials will take place preferably on Monday and Thursday from 12:00 to 14:00 The tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. In the face-to-face modality, the tutorials will be held in office D42, block C, 3rd floor of the CC Experimental Building, as long as the teacher does not have to attend to other academic obligations. To optimize the time, it is necessary for the student to contact the teacher in advance

Case studies	The tutorials will take place preferably on Monday and Thursday from 12:00 to 14:00 The tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. In the face-to-face modality, the tutorials will be held in office D42, block C, 3rd floor of the CC Experimental Building, as long as the teacher does not have to attend to other academic obligations. To optimize the time, it is necessary for the student to contact the teacher in advance
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Assessment							
	Description	Qualification	Training and Learning Results				
Seminars	Individual written report on the activity made in seminars. It can include questionnaires.	10	A1 A2 A3 A5	B1 B5	C12 C13 C14	D1 D2	
Field practice	This activity is of compulsory assistance given his experimental character Comprises a brief individual or group written summary, depending on the nature of the field trip. It must reflect the activity carried out in the field and its scope.	10	A2 A5	B1		D1 D5	
Case studies	This activity is of compulsory assistance given his experimental character Group report that reflects the activities carried out during the practices, which will include objectives, methodology, results and conclusions.	25	A2 A3 A5	B1 B5	C13 C14	D1 D2	
Lecturing	This activity is of compulsory assistance given his experimental character Written individual test of 2 to 4 hours, whose aim will be the global evaluation of the process of learning and the acquisition of skills and knowledge. It will comprise one or several of the following types of assessments: long questions to elaborate, short questions, tests, problem resolution, interpretation of images, maps and diagrams.	40	A1 A2 A3 A5	B1	C12 C13 C14	D1 D2	
Autonomous problem solving	Resolve questions and problems related with theoretical contents that the students have to tackle of autonomous form.	15	A1 A2 A3	B1	C12 C13 C14	D1 D2	

Other comments on the Evaluation

Attendance field trip, seminars and practices is an essential condition to be qualified. These activities are compulsory attendance given their experimental nature.

If one of the parts is not qualified, the grade that will be assigned will be the pure average divided by 2.

You must reach at least 50% of the maximum partial score in each of blocks to be able to compensate by taking the average with the qualification obtained in the others blocks.

If the subject is not passed, the grade obtained in any of the blocks is not retained for the following course.

2º chance

It will consist of an exam that will evaluate the theoretic and practical contents of the subject, provided that the students have attended seminar classes, practices and field trips

Global evaluation option

The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start. Given the experimental nature of the practices, attendance at them is mandatory to be eligible for this evaluation option. **Failure to attend the practices, with no justified cause invalidates this possibility, as well as the opportunity for extraordinary evaluation (2nd opportunity).**

Other considerations:

The official exam dates can be found at: http://mar.uvigo.es/alumnado/*exámenes/

Students who takes this subject are required to behave responsibly and honestly. It considers inadmissible any form of fraud (copy or plagiarism) directed to distort level of knowledges and skills reached in all type of proof, report or work.

Fraudulent conduct may suppose suspend the subject during a full course. An internal record of these actions will be kept so that, in case of recidivism, request the opening of a disciplinary file to the rector.

Sources of information
Basic Bibliography
E.A. Hailwood, R. Kidd, Marine Geological Surveying and Sampling , 978-94-010-6763-8 (Print) 978-94-009-0615-0 (Online), Springer, 1990
E. J. W. Jones, Marine Geophysics , 978-0-471-98694-2, Wiley, 1999
H.D. Schulz, Matthias Zabel, Marine Geochemistry , 978-3-540-32143-9 (Print) 978-3-540-32144-6 (Online), Springer, 2006
M. E. Tucker, Techniques in Sedimentology , 978-0632013722, Wiley-Blackwell, 1991
Bernabeu, A.M., Abilleira, P., Fernández-Fernández, S., Lersundi-Campistegui, A. V., Capítulo XXIX. Métodos para la evaluación del transporte de sedimentos en el litoral. En: Métodos Y Técnicas En Investigación Marina , 9788430952083, TECNOS, 2011
K Mohamed, D. Rey, Capítulo XXX. Técnicas de magnetismo ambiental de utilidad en el estudio de sedimentos marinos. En: Métodos Y Técnicas En Investigación Marina , 9788430952083, TECNOS, 2011
B. Rubio, D. Rey, A.M. Bernabeu, F. Vilas, I. Rodríguez Germade, A. Ares, Capítulo XXXI. Nuevas técnicas de obtención de datos geoquímicos de alta resolución. En: Métodos Y Técnicas En Investigación Marina , 9788430952083, TECNOS, 2011
I.W. Croudace; R.G. Rothwell, Micro-XRF Studies of Sediment Cores: Applications of a non-destructive tool for the environmental sciences , Springer, 2015
CC W Finkl; C. Makowski, Seafloor Mapping along Continental Shelves: Research and Techniques for Visualizing Benthic Environments , Springer, 2016
Complementary Bibliography
http://walrus.wr.usgs.gov/pubinfo/margeol2.html ,
Comission of marine cartography, http://www.shoa.cl/ica/index.html ,
GEODAS Geophysical Data Management System of the NOAA National Geophysical Data Center (NGDC), http://www.ngdc.noaa.gov/mgg/geodas/geodas.html ,
Recommendations
Subjects that continue the syllabus
Geological oceanography II/V10G061V01308
Subjects that are recommended to be taken simultaneously
Biological oceanography I/V10G061V01301
Subjects that it is recommended to have taken before
Geology: Geology 1/V10G061V01103
Geology: Geology 2/V10G061V01108
Coastal and marine sedimentary habitats/V10G061V01207
Sedimentology/V10G061V01205
Other comments
DELIVERY OF ASSIGNMENTS
Unless it is stated otherwise, all the hand outs have to be delivered in electronic format and uploaded to the MooVI platform. No email, or paper submission will be accepted or acknowledged.
IMPORTANT
All deadlines expire at 24:00 of the marked day.
REGARDING THE AUTHORSHIP OF THE GROUP ASSIGNMENTS
Submission of the assignment is the responsibility of the coordinator, who must state the participants. All coauthors must upload their copy at MooVI to claim co-authorship.
Authorship cannot be modified after the deadline of the assignment.
Authors that appear in more than one assignment will cause the assignment to fail for all authors.
Plagiarism, partly or in whole, will cause course to fail and will be reported to the Dean for disciplinary action.
THE MooVI PLATFORM IS THE OFFICIAL COMMUNICATION CHANNEL OF THE COURSE
Any agreement has to be stated in the MooVI platform to be official.

IDENTIFYING DATA				
Chemistry applied to the marine environment I				
Subject	Chemistry applied to the marine environment I			
Code	V10G061V01304			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Couce Fortúnez, María Delfina Besada Pereira, Pedro			
Lecturers	Besada Pereira, Pedro Castro Fojo, Jesús Antonio Couce Fortúnez, María Delfina Teijeira Bautista, Marta			
E-mail	delfina@uvigo.es pbes@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	<p>This subject includes the study of elements, inorganic substances and organic substances that can reach and alter the marine environment, acting as pollutants. Behaviour, influence and prevention of the effects produced by these elements, inorganic substances and organic substances in the environment will be studied. Moreover, the study of marine natural products (classification, function, pharmacological interest) will be addressed.</p> <p>English Friendly subject: International students may request from the teachers:</p> <p>a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English</p>			

Training and Learning Results				
Code				
A1	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study			
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study			
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues			
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy			
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.			
B2	Plan and execute surveys in the field and laboratory work, applying basic tools and techniques for sampling, data acquisition and analysis in the water column, sea bottom and marine substratum.			
B3	Recognize and implement good practices in measurement and experimentation, and work responsibly and safely both in field surveys and in the laboratory.			
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.			
C6	Acquire the fundamentals and terminology of chemical processes.			
C7	Apply to the marine and coastal environment the principles and methods used in Chemistry.			
C8	Know the main pollutants, their causes and effects in the marine and coastal environment.			
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.			
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.			

Expected results from this subject				
Expected results from this subject	Training and Learning Results			
To describe global cycles of the elements, including the input and output processes.	A1	B1	C6	D1
	A2			
	A3			
	A5			

To define and to explain concepts, principles and sources related to chemical pollution.	A1 A2 A3 A5	B1	C6 C8	D1 D5
To describe the chemical composition and speciation in seawater and to determine the mechanisms and factors that regulate it.	A1 A2 A3 A5	B1	C6	D1
To determine the processes that regulate chemical species complexation.	A1 A2 A3 A5	B1	C6	D1
To identify the toxicity mechanisms of metal ions, as well as the factors that determine and control the biomethylation processes.	A1 A2 A3 A5	B1	C6 C7 C8	D1 D5
To identify the toxicity mechanisms of the major organic pollutants.	A1 A2 A3 A5	B1	C6 C7 C8	D1 D5
To identify the most important natural products in the marine environment.	A1 A2 A3 A5	B1	C6	D1 D5
To identify the main interactions between marine organisms.	A1 A2 A3 A5	B1	C6 C7	D1
To describe the main applications of marine natural products.	A1 A2 A3 A5	B1	C6 C7	D1 D5
To analyze the results obtained in the laboratory using the theoretical concepts.	A1 A2 A3 A5	B1 B2 B3 B4	C6	D1
To develop the necessary skills for the resolution of the applications related with the subject.	A1 A2 A3 A5	B1 B2 B3 B4	C7	D1 D5

Contents

Topic	
1. Introduction to environment	Cycles of the elements in the environment
2. Pollution of marine environment	Generalities. Major sources of pollution
3. Metal speciation	Aerobic and anaerobic environments. Pourbaix diagrams
4. Metals and metallic species	General characteristics. Effects of metal complexation with natural ligands
5. Pollution by heavy metals	Biogeochemical cycles. Methylation processes. Mechanisms of toxicity associated. Applicable defense and detoxication procedures.
6. Reactivity of pollutants non-metallic chemical species	Introduction: carbonates, nitrates, phosphates, sulfates, perchlorates
7. Radioactive pollution in marine environment	Study, behavior and control of radioactive pollutants
8. Organic pollutants in the marine water	Classification. Functional and structural description. Origin of marine pollution
9. Chemical transformations of organic compounds	Solubility of organic compounds. Reactions of organic pollutants with nucleophilic species. Redox processes. Photochemical and biological transformations
10. Types of natural products	Terpenes, steroids and carotenoids. Oxygen compounds: Phenols, lignans, coumarins, macrolides and polyethers. Nitrogenous compounds: alkaloids, peptides
11. Marine natural products and their biologic function	Metabolite transfer in marine ecosystems. Biogenesis. Incorporation of halogens: Haloperoxidases
12. Marine chemical ecology	Chemical interactions between organisms. Organic compounds of marine origin and their ecological function
13. Marine natural products in drug discovery	Organic compounds of marine origin: isolation, characterization and biological activity

Planning			
	Class hours	Hours outside the classroom	Total hours
Seminars	16	24	40
Laboratory practical	12	2	14
Mentored work	0	17	17
Lecturing	24	48	72
Problem and/or exercise solving	1	0	1
Report of practices, practicum and external practices	0	4	4
Objective questions exam	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Seminars	Seminars will be used for further working on some of the theoretical contents, and also for problems resolution as a complement of the masterclass. Students may prepare a topic of interest related with the subject.
Laboratory practical	Application of laboratory techniques in practical problems related to the subject
Mentored work	Preparation and presentation of a tutored work on a topic related to the contents
Lecturing	Theoretical classes in which the professor and students will work the basic concepts of the matter

Personalized assistance	
Methodologies	Description
Lecturing	Tutoring, support and motivation in the learning process, in the classroom, personally in the professor's office as well as through e-mail or the virtual campus. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation. Tutorial hours: P. Besada: monday, wednesday and thursday from 11:00 to 13:00 h D. Couce: tuesday, wednesday and thursday from 12:00 to 14:00 h
Seminars	Tutoring, support and motivation in the learning process, in the classroom, personally in the professor's office as well as through e-mail or the virtual campus. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation. Tutorial hours: P. Besada: monday, wednesday and thursday from 11:00 to 13:00 h D. Couce: tuesday, wednesday and thursday from 12:00 to 14:00 h
Laboratory practical	Tutoring, support and motivation in the learning process, in the classroom, personally in the professor's office as well as through e-mail or the virtual campus. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation. Tutorial hours: P. Besada: monday, wednesday and thursday from 11:00 to 13:00 h J. Castro: tuesday and thursday from 10:00 to 13:00 h
Mentored work	Tutoring, support and motivation in the learning process, in the classroom, personally in the professor's office as well as through e-mail or the virtual campus. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation. Tutorial hours: P. Besada: monday, wednesday and thursday from 11:00 to 13:00 h D. Couce: tuesday, wednesday and thursday from 12:00 to 14:00 h

Assessment						
	Description	Qualification	Training and Learning Results			
Mentored work	Students will carry out a brief tutored work, evaluating the report presented and its presentation	25	A1 A2 A3 A5	B1 C8	C6 D5	D1
Problem and/or exercise solving	The student will have to resolve and deliver the questionnaires proposed in the classroom. It will value the participation and attitude of the student, his capacity to relate and apply the concepts purchased.	10	A1 A2 A3 A5	B1 C7 C8	C6	D1
Report of practices, practicum and external practices	Students must present a report of the virtual practices carried out. Attendance at the laboratory sessions as well as preparation of the report is compulsory to get promoted. The attitude in the lab sessions, the skills and the understanding of the experimental techniques used will be evaluated.	25	A1 A2 A3 A5	B1 B2 B3 B4	C6 C7	D1 D5

Objective questions exam	Final exam in which the theoretical contents of the subject worked in the master sessions and in the seminars will be evaluated. The contents of this subject are divided in two blocks (Chapters 1-7 and 8-13) so the test will also be divided into two parts. To get promoted the student must obtain a minimum of 3.5 out of 10 in each of the two parts into which the exam is divided.	40	A1 A2 A3 A5	B1 	C6 C7 C8	D1
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Other comments on the Evaluation

The official exam schedule can be checked at the following link:

<http://mar.uvigo.es/alumnado/examenes/>

The final qualification will be the sum of all paragraphs whenever the required minimum is reached. If the required minimum is not reached the final qualification will be the one of the final exam.

The participation of the student in the laboratory sessions, in the tutored work or in any exam will involve the condition of presented and the assignment of a score.

The percentages in each of the paragraphs will be maintained in the 2nd assesment call (July).

Global assessment option: The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start. Given the experimental nature of the practices, attendance at them is mandatory to be eligible for this evaluation option. **Failure to attend the practices, with no justified cause invalidates this possibility, as well as the opportunity for extraordinary evaluation (2nd opportunity).**

Students are strongly requested to fulfil a honest and responsible behaviour. It is consider inadmissible any kind of fraud (copy or plagiarism) aimed to falsify the level of knowledge and skills achieved in exams, evaluations, reports or any kind of teacher´s proposed work. Fraudulent behaviour may involve failing the subject during a whole academic year. An internal record of these actions will be kept to request, in case of reincidence, the opening of a disciplinary file.

Sources of information

Basic Bibliography

I. Bodek, W.J. Lyman, W.F. Reehl y D.H. Rosenblatt, **Environmental Inorganic Chemistry**, Pergamon Press, 1988

R.P. Schwarzenbach, P.M. Gschwend, D.M. Imboden, **Environmental Organic Chemistry**, 2, John Wiley & Sons Inc, 2003

R. Chang, **Química**, 11, Mc Graw Hill, 2013

P. Yurkanis Bruice, **Química Orgánica**, 5, Prentice Hall México, 2007

Complementary Bibliography

S. E. Manahan, **Environmental chemistry**, 9, CRC Press, 2009

H. G. Seiler, H. Sigel, A. Sigel, **Handbook on toxicity of inorganic compounds**, Marcel Dekker, 1988

J. W. Moore, **Inorganic Contaminants of Surface Water**, Springer, 1991

Paul M. Dewick, **Medicinal natural products: A biosynthetic approach**, 3, John Wiley & Sons Inc, 2009

J. B. McClintock, B.J. Baker, **Marine chemical ecology**, CRC Press, 2001

M.A. Martínez Grau, A.G. Csáky, **Técnicas experimentales en síntesis orgánica**, 2, Síntesis, 2012

Journal of Natural Products,

Natural Products Reports,

Marine Chemistry,

Marine Pollution Bulletin,

Recommendations

Subjects that continue the syllabus

Marine contamination/V10G061V01401

Subjects that it is recommended to have taken before

Chemistry: Chemistry I/V10G061V01105

Chemical oceanography I/V10G061V01204

IDENTIFYING DATA				
Physiology of marine organisms				
Subject	Physiology of marine organisms			
Code	V10G061V01305			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Pedrol Bonjoch, María Nuria Conde Sieira, Marta			
Lecturers	Blanco Imperiali, Ayelén Melisa Conde Sieira, Marta Pedrol Bonjoch, María Nuria			
E-mail	pedrol@uvigo.es mconde@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	Study of the operation of the marine organisms (animal and vegetal) and of the mechanisms that make possible his adaptation to the half. It will loan special attention the those physiological **appearances mothers related with the integration of the pertinent information of the half marine and the generation of specific answers.			
	English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.
B5	Develop, implement and write basic or applied projects in oceanography from a multidisciplinary perspective.
C9	Acquire basic knowledge about the structural and functional organization and the evolution of marine organisms.
C10	Know the biological diversity and functioning of marine ecosystems.
C11	Apply the knowledge and techniques acquired to the characterization and sustainable use of living resources and marine ecosystems.
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.
D2	Acquire the ability to learn autonomously, continuously and collaboratively, organizing and planning tasks over time.
D4	Ability to communicate orally and in writing in Galician language.
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
2. To know the relationships among the photosynthetic marine organisms and the marine environment by means of the study of changing physiological processes	A2 B1 C9 D2 A3 C10 D5 A5
3. To handle equipments and techniques to study plant physiology.	A2 B1 C11 D2 A3 B4 D4 A5 B5 D5
4. To understand the scientific methodology and the technologies applied to plant physiology research.	A3 D2 A5 D4 D5

5. To gain capacity of analysis and approaching to hypothesis in plant physiology.	A2 A3			
6. To know the relationships among the photosynthetic marine organisms and the abiotic and biotic marine environments, by means of the study of their adaptations and the physiological processes of acclimation (functional types, osmoregulation, fotoprotection, biomass partitioning).	A2 A5	B1	C10	D4 D5
ANIMAL PHYSIOLOGY:	A2	B1		
7. To know the mechanisms of acquisition and integration of the sensory information in marine animals	A3 A5			
8. To know the physiological bases of muscular activity and its implication in aquatic locomotion	A3	B1		
9. To know in marine animals the mechanisms trough which synthesis, release, transport and the action of hormones synthesised by endocrine glands and the nervous system of marine animals occur.	A2 A3	B1		
10. Knowing the corporal fluids and the functioning of cardiovascular systems.	A3	B1	C9	
11. To know the mechanisms of gas exchange between the animals and the water where they live.	A3	B1		
12. To know the mechanisms for wastes elimination and of osmotic regulation in distinct groups of marine animals.	A3	B1		
13. To know how animals obtain energy through food consumption, and how to use such energy as well.	A3 A5	B1		D5
15. To know the general and basic terminology in Animal Physiology.	A3	B1		
17. To understand the general functioning of the animal as a whole, emphasizing in the role played by the integratory and coordinatory systems.	A2 A3	B1	C9 C10	D5
18. To understand basic aphysiology-related aspects, such as aquaculture.	A2 A3 A5	B1	C11	D1 D5

Contents

Topic

PLANT PHYSIOLOGY:	<ol style="list-style-type: none"> 1. Plant Physiology in the ocean. 2. Cell and tissue basic characteristics photosynthetic marine organisms 3. Water relations in photosynthetic marine organisms. Osmoregulation and osmoprotection. 4. Mineral nutrition in marine environments. 5. Photosynthesis: definition and physiological, ecological and evolutionary relevance. 6. The photosynthetic organelles. 7. Light and photosynthetic pigments. 8. The photochemical phase of photosynthesis. 9. The biochemical phase of photosynthesis. 10. Mechanisms of carbon gain and concentration in photosynthetic marine organisms.
ANIMAL PHYSIOLOGY:	<ol style="list-style-type: none"> 1. Physiological bases of excitability 2. The nervous system and the neural communication 3. Physiology of the systems effectors in marine animals: muscular activity and locomotion, cromatophora and bioluminescence 4. Sensory physiology in marine animals: mecanoreception, electroreception, magnetoreception, quimioreception, fotoreception and vision. 5. Physiology of the neuroendocrine and endocrine systems in marine animals 6. Circulatory fluids and operation of the cardiovascular systems in marine animals 7. Operation of the respiratory systems in marine animals 8. Physiology of excretion and osmorregulation in marine animals 9. Physiology of the digestive systems in marine animals

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	70	98
Laboratory practical	10	4	14
Mentored work	0	12	12
Discussion Forum	0	2	2
Seminars	5	15	20
Objective questions exam	0.7	0	0.7
Essay questions exam	1	0	1
Problem and/or exercise solving	0.3	0	0.3

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Lecturing	2-4 weekly hours until complete the planning. To be developed in the corresponding classroom, with all the enrolled students. Theory sessions will be supported by PowerPoint presentations. The educational materials will be at the disposal of the students on the Moovi platform.
Laboratory practical	The students will assist 3 sessions of practice in the laboratory: two sessions of 2.5 h each in Animal Physiology, and one session of 5 h in Plant Physiology. Attendance is compulsory.
Mentored work	PLANT PHYSIOLOGY: short Activities of cooperative learning in the classroom, in spontaneous or random groups. Immediate delivery. They are a complement to the evaluation, not compulsory. Each activity delivered can add up to 0.1 points to the final mark of PLANT PHYSIOLOGY, although they do not penalize if they are not delivered.
Discussion Forum	PLANT PHYSIOLOGY, through the platform Moovi: -virtual Forum of review: scientific Articles and websites of cytology and histology of photosynthetic marine organisms -virtual Forum of innovation and state of the art: scientific Articles and websites of physiological /ecophysiological subjects of photosynthetic marine organisms -virtual Exercises proposing questions for the final exam Each quality contribution to the forum can add up to 0.1 points to the final mark of PLANT PHYSIOLOGY, although they do not penalize if you do not participate.
Seminars	In the module of ANIMAL PHYSIOLOGY seminars will be devoted to the planning and exhibition of subjects elaborated by the distinct groups of students In the module of PLANT PHYSIOLOGY seminars will be devoted to the resolution of problems

Personalized assistance

Methodologies	Description
Seminars	Resolution of doubts and difficulties to the groups or personnel if necessary. During the seminar and in tutorials, Monday and Friday from 11:00 to 12:00.
Lecturing	Resolution of doubts and difficulties to the group or personal if necessary. During the session and in tutorials, Monday and Friday from 11:00 to 12:00. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimize the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation.
Laboratory practical	Resolution of doubts and difficulties to the groups or personal if necessary. During the practices and in tutorials, Monday and Friday from 11:00 to 12:00.
Mentored work	Resolution of doubts and difficulties to the groups the groups or personal if necessary. In the classroom and in tutorials, Monday and Friday from 11:00 to 12:00.
Discussion Forum	Feedback through the platform Moovi
Tests	Description
Debate	Feedback through the platform Moovi

Assessment

	Description	Qualification	Training and Learning Results			
Lecturing	Attendance will be evaluated	0	A2	B1	D5	
	There will be final evaluation tests for both modules. The relative weighting of each will be 50%. A minimum of a 4 in each module is required to pass the exam.		A3	B4		
	The final exam will consist of objective tests, developmental questions and problem solving.		A5	B5		
Laboratory practical	In the module of Plant Physiology (5% of the qualification) the evaluation will be by attendance and questions in the final exam.	10	A2	B1	C9	D1
	In the module of Animal Physiology (5% of the qualification) the evaluation will be by attendance.		A3	B4	C10	D5
			A5	B5	C11	

Mentored work	Volunteer for the module of Plant Physiology.	0	A2 A3 A5	B1	C9 C10	D1 D2 D4 D5
	(Short collaborative learning activities in the classroom, in spontaneous or random groups. Immediate delivery. They are complementary to the evaluation, not mandatory. Each classroom activity delivered raises one tenth of the final grade of PLANT PHYSIOLOGY, although they do not penalize if they are not delivered).					
Discussion Forum	Voluntary for the module Plant Physiology	0	A2 A3 A5		C10 C11	D1 D2 D4 D5
	(Each quality contribution to the forums adds one tenth to the final grade of PLANT PHYSIOLOGY, although they do not penalize if you do not participate).					
Seminars	Attendance is mandatory for the continuous evaluation, given its experimental and practical nature.	20	A2 A3 A5	B1 B4 B5	C9 C10 C11	D1 D2 D4 D5
	In the Plant Physiology module, the mark will be based on attendance and performance (5%), and the problems will be subject of the exam.					
	In the Animal Physiology module, students in groups of 2-3 will elaborate a work to be presented in the classroom, and the mark will be based on attendance and performance (15%).					
	For the students who opt for the global evaluation, the delivery of the report of problems of Plant Physiology and the work of Animal Physiology is voluntary and can raise the final mark up to two points.					
Objective questions exam	Mandatory	25	A2 A3 A5	B1	C9 C10 C11	D4
Essay questions exam	Mandatory	35	A2 A5	B1 B5	C9 C10	D4
Problem and/or exercise solving	Mandatory	10	A3	B4	C10	D1 D4

Other comments on the Evaluation

To pass the subject, it is required that the overall qualification of each of the modules (exams, seminars and practices) separately is not less than 4 points.

The exams of the Animal Physiology module will take place during class hours once the theoretical module is finished. The exams and problem-solving of the Plant Physiology module will be held once the theoretical module has been completed on the date, time, and place of the official evaluation exams, which will be published on the official website of the Faculty of Marine Sciences (<http://mar.uvigo.es/alumnado/examenes/>).

All exam and delivery dates will be published on the teledocency platform Moovi. **The evaluation tests of both modules in the 2nd opportunity** will be held on the date, time, and place of the official evaluation tests of the 2nd opportunity, which will be published on the official website of the Faculty of Marine Sciences (<http://mar.uvigo.es/alumnado/examenes/>). Students who take the continuous assessment may take the 2nd opportunity only for the failed module, and the mark of the approved module, practices and seminars will be kept.

Global evaluation option:

The application for this evaluation option will have to be submitted in the time and form determined by the Center, which will be published prior to the academic start. Given the experimental nature of the practicals, attendance is mandatory in order to be eligible for this evaluation option.

The evaluation tests (exams and problem solving) will be held on the date, time and place of the official evaluation tests, which will be published on the official website of the Faculty of Marine Sciences (<http://mar.uvigo.es/alumnado/examenes/>). The evaluation tests of both modules in the 2nd opportunity will be held on the date, time and place of the official evaluation tests of the 2nd opportunity, which will be published on the official website of the Faculty of Marine Sciences (<http://mar.uvigo.es/alumnado/examenes/>). Students who opt for a global evaluation may also take the 2nd opportunity only to the failed module, and the mark of the approved module will be kept. Failure to attend the practicals without a justified cause invalidates this possibility, as well as the opportunity for extraordinary evaluation (2nd opportunity).

Students taking this course are required to behave responsibly and honestly. Any form of fraud (copying or plagiarism) aimed at falsifying the level of knowledge and skills achieved in any kind of test, report or work is considered unacceptable. Fraudulent behavior may result in the suspension of the subject for an entire course. An internal record of these actions will be kept so that, in case of recurrence, a disciplinary file may be requested to be opened to the rector's office.

Sources of information

Basic Bibliography

Hill, R.W. et al, **Fisiología animal.**,

Moyes, C. y Schulte, P., **Principios de fisiología animal.**,

Withers, P.C., **Comparative Animal Physiology.**,

Complementary Bibliography

Randall,D. et al., **Fisiología animal.**,

Willmer, P., Stone, G., Johnston, I., **Environmental physiology of animals.**,

Azcón-Bieto J, Talón M, **Fundamentos de Fisiología Vegetal**, 2ª ed. Madrid: McGraw-Hill Interamericana,

Taiz L, Zeiger E, **Fisiología vegetal**, Publicacions de la Universitat Jaume I,

Lobban CS, Harrison PJ, **Seaweed Ecology and Physiology**, Cambridge University Press, New York,

Kirk JTO, **Light and photosynthesis in aquatic ecosystems**, 3rd ed. Cambridge, UK: Cambridge University Press,

Larkum AWD, Robert JO, Duarte CM, **Seagrasses: biology, ecology, and conservation**, Dordrecht (The Netherlands): Springer,

Taiz L et al., **Plant Physiology and Development, Sixth Edition**, Sinauer Associates, Inc.,

Recommendations

Subjects that are recommended to be taken simultaneously

Aquaculture/V10G061V01310

Biological oceanography I/V10G061V01301

Biological oceanography II/V10G061V01306

Subjects that it is recommended to have taken before

Biology: Biology I/V10G061V01101

Biology: Biology 2/V10G061V01106

Marine botany/V10G061V01202

Marine zoology/V10G061V01210

Other comments

Students are strongly requested to fulfil a honest and responsible behaviour. It is considered completely unacceptable any alteration or fraud (i.e., copy or plagiarism) contributing to modify the level of knowledge and abilities acquired in exams, evaluations, reports or any kind of teacher's proposed work. Fraudulent behaviour may cause failing the course for a whole academic year. An internal dossier of these activities will be built and, when reoffending, the university rectorate will be asked to open a disciplinary record.

IDENTIFYING DATA				
Biological oceanography II				
Subject	Biological oceanography II			
Code	V10G061V01306			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Marañón Sainz, Emilio			
Lecturers	Marañón Sainz, Emilio Mouriño Carballido, Beatriz Teira Gonzalez, Eva Maria			
E-mail	em@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	This course addresses the study of the interaction between the composition and dynamics of biological communities and the production and fate of organic matter in the ocean. The diversity and metabolic activity of microbial plankton receive special attention, due to their key role in the regulation of marine biogeochemical cycles. Multiple levels of organization are considered, including cells, populations, communities and the ecosystem. The ultimate aim is to understand the role of ocean's biology in the functioning of the Earth system.			
English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English. b) tutoring sessions in English. c) exams and assessments in English.				

Training and Learning Results				
Code				
A1	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study			
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.			
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.			
C10	Know the biological diversity and functioning of marine ecosystems.			
C11	Apply the knowledge and techniques acquired to the characterization and sustainable use of living resources and marine ecosystems.			
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.			
D2	Acquire the ability to learn autonomously, continuously and collaboratively, organizing and planning tasks over time.			

Expected results from this subject				
Expected results from this subject	Training and Learning Results			
Know and understand how organisms and communities drive the cycling of matter in the ocean, linking the physiological and ecological traits of key functional groups with their biogeochemical role.	A1	B1	C10	
Ability to connect the different physical, chemical and biological processes that determine the role of the ocean within the Earth system.	A1	B1	C10	D1
Know and understand the natural and anthropogenic variability in pelagic ecosystems and marine biogeochemical cycles, as well as their response to processes of global environmental change.	A1		C10 C11	D1
Ability to interpret biological oceanography data.		B4	C10 C11	D1
Ability to use computing applications to run mathematical models of biogeochemical processes.		B4	C11	D2
Ability to use specialised bibliography				D1 D2

Contents	
Topic	
Unit 1. Introduction	Distribution and abundance of chemical elements in the sea. Metabolic pathways and key plankton functional groups. Properties of element cycles.

Unit 2. Production of organic matter.	Variability and control of primary production. Stoichiometry of phytoplankton production. Dynamics of dissolved organic matter. New and regenerated production. Trophic organization and biogeochemical functioning of the ecosystem.
Unit 3. Remineralization.	Distributions of nutrients and oxygen. Oxygen utilization rates. Stoichiometric relations. Heterotrophic processes: quantification and variability. Photosynthesis respiration balance. Balance between N ₂ fixation and denitrification. Global nitrogen cycle.
Unit 4. Export.	The biological pump. Methodological issues. Spatio-temporal variability in export. Attenuation of vertical fluxes: controlling factors. Shallow and deep sedimentation. Coast-ocean gradients.
Unit 5. Biogeochemical processes in the sediments.	Physical structure of the sediment. Coast-ocean gradients. Reactions of organic matter oxidation. Redox potential. Spatio-temporal variability in benthic fluxes. Global carbon budget in the sediments.
Unit 6. The global carbon cycle.	Chemistry of dissolved inorganic carbon (DIC). Distribution and abundance of main DIC forms. CO ₂ fluxes between ocean and atmosphere. The biological pump and the solubility pump. Global C cycle: current unbalances.
Unit 7. The calcium carbonate cycle.	CaCO ₃ oceanic budget. Carbonate saturation. Production, export and redissolution of CaCO ₃ . Distribution of carbonates in the sediments. Pelagic calcification: coccolithophore blooms and biogeochemical impacts.
Unit 8. Global change and the biology of the ocean.	Multiple environmental stressors. Warming. Acidification. Deoxygenation. Eutrophication. Impacts on species, communities, ecosystems and biogeochemical cycles. Global feedback processes.
Seminar program.	Biomass, production and growth of phytoplankton. Observation in oceanography: formulation and testing of hypotheses. Ecological and biogeochemical role of iron. Distribution patterns of diatoms and coccolithophores. Biogeochemistry of coastal eutrophication.
Practical session program.	Data analysis of phytoplankton cell size, abundance and metabolism. Graphical representation of xyz distributions. Open-ocean nitrogen budgets. Modelling the global carbon cycle using computer models. Case analysis.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	22	46	68
Seminars	10	15	25
Problem solving	10	25	35
Practices through ICT	10	10	20
Objective questions exam	1	0	1
Problem and/or exercise solving	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation of fundamental contents of the course, supported by graphic material.
Seminars	Using data and scientific articles, specific topics are explored in detail. Subjects tackled include, amongst others, the ecology and biogeochemical role of diatoms and coccolithophores, the ecological and biogeochemical importance of iron, and ocean acidification.
Problem solving	Practical cases are solved using real data presented numerically and graphically.
Practices through ICT	Numerical modelling of the carbon biogeochemical cycle. Analysis of data on the size-scaling of phytoplankton abundance, biomass and metabolism.

Personalized assistance

Methodologies	Description
Lecturing	Students can ask for assistance on any aspect of the course both on line and during personal interviews. Schedule for personal attention is Mon, Tue from 12:00 to 14:00. This schedule may be modified due to other teacher's commitments. Students are encouraged to contact the teacher via email to schedule interviews at a mutually convenient time.
Seminars	Students can ask for assistance on any aspect of the course both on line and during personal interviews. Schedule for personal attention is Mon, Tue from 12:00 to 14:00. This schedule may be modified due to other teacher's commitments. Students are encouraged to contact the teacher via email to schedule interviews at a mutually convenient time.

Problem solving Students can ask for assistance on any aspect of the course both on line and during personal interviews. Schedule for personal attention is Mon, Tue from 12:00 to 14:00. This schedule may be modified due to other teacher's commitments. Students are encouraged to contact the teacher via email to schedule interviews at a mutually convenient time.

Assessment				
	Description	Qualification	Training and Learning Results	
Seminars	Students write a short essay in which they provide a critical synthesis of a scientific article. The clarity and correctness of the writing, as well as the rigour in the use and application of scientific concepts, are particularly valued. The mark obtained in June is maintained for the July call. Upon consultation with the course's coordinator, students may resubmit this work for the July call.	20	B1	C10 D1 D2
Problem solving	Students solve practical cases similar to those used during the practical sessions. The mark obtained the June call is maintained for the July call. Upon consultation with the course's coordinator, students may resubmit this work for the July call.	20	B1 B4	C10 C11 D1 D2
Objective questions exam	Intermediate test with closed answers (true/false, multiple choice) that assess the acquisition of knowledge and skills covered during lectures and seminars during the first half of the course.	20	A1 B1 B4	C10
Problem and/or exercise solving	Final written test includes short questions and practical cases. The test is designed to assess the acquisition of knowledge and skills covered during the lectures, seminars and practical sessions.	40	A1 B1 B4	C10 C11

Other comments on the Evaluation

The date, time and place of exams will be published in the official web of the Faculty of Marine Sciences:

<http://mar.uvigo.es/alumnado/examenes/>

Global assessment option: The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start.

The mark obtained in the two tasks (synthesis of a scientific article and case resolution) is kept for the 2nd opportunity call. However, the marks obtained in the intermediate test and in the final written test are NOT kept for the 2nd opportunity call. Therefore, all students who make use of the second call must take the final exam, which represents 60% of the total mark for the course. It is possible, after consulting with the coordinator, to deliver the two tasks again for consideration in the second call.

All enrolled students must deliver the two tasks, because the marks obtained in earlier academic years are not kept.

Students must behave honestly and responsibly. Any form of copying or plagiarism, intended to alter the level of acquired knowledge and abilities, in exams, evaluations, reports or any other kind of student work is completely unacceptable. Fraudulent behaviour may result in the failing of the course for a whole academic year. An internal dossier of these activities will be kept and, in cases of reoffending, the University Rectorate will be asked to open a disciplinary enquiry[]

Sources of information

Basic Bibliography

Libes, S., **An introduction to marine biogeochemistry**, Wiley, 2009

Sarmiento, J., L., Gruber, N, **Ocean biogeochemical dynamics**, Princeton University Press, 2006

Williams RG, Follows MJ, **Ocean dynamics and the carbon cycle : principles and mechanisms**, Cambridge University Press, 2011

Complementary Bibliography

Miller, C. B., **Biological Oceanography**, Blackwell, 2012

Steele JH, Turekian KK, Thorpe SA, **Encyclopedia of Ocean Sciences**, 2a, Elsevier, 2008

Middelburg, Jack J., **Marine Carbon Biogeochemistry A Primer for Earth System Scientists**, Springer, 2019

Falkowski PG, **Life's Engines: How Microbes Made Earth Habitable**, Princeton University Press, 2015

Schlesinger, W.H., **Biogeoquímica: un análisis del cambio global.**, Ariel, 2000

Gasol JM, Kircvman (Eds.), **Microbial ecology of the oceans**, 3a, Wiley-Blackwell, 2018

Recommendations

Subjects that it is recommended to have taken before

Marine Ecology/V10G061V01206

Biological oceanography I/V10G061V01301

IDENTIFYING DATA				
Physical oceanography II				
Subject	Physical oceanography II			
Code	V10G061V01307			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Varela Benvenuto, Ramiro Alberto			
Lecturers	Varela Benvenuto, Ramiro Alberto			
E-mail	rvarela@uvigo.es			
Web	http://www.gofuvi.org			
General description	This course, mostly a practical one, brings to the student knowledges of the fundamental methodologies used in physical oceanography.			
	English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results				
Code				
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study			
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues			
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences			
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.			
C3	Describe how works the global ocean circulation, its forcings and its climate implications.			
C4	Know, analyze and interpret the physical properties of the ocean according to current theories, as well as to know the most relevant sampling tools and techniques.			
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.			
D2	Acquire the ability to learn autonomously, continuously and collaboratively, organizing and planning tasks over time.			
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.			

Expected results from this subject				
Expected results from this subject	Training and Learning Results			
The student has to know how to calculate variables derived from the basic parameters such as speed of the sound, dynamic height, density, frequency of Brunt-Vaisala, stability and interpret them properly.	A2	C3	D1	
	A3	C4	D2	
	A4			
The student has to understand the principles and main uses of several advanced oceanographic instruments and its implications in current physical oceanography (i.e., current meters, CTD, High Frequency radars, Argo profilers, mooring lines)	A2	B1	C4	D1
	A3			D2
	A4			
The student should understand and distinguish the advantages and disadvantages of the several wind, wave and tide related energy systems available	A2	C3	D1	
	A3	C4	D2	
			D5	
The student has to be able to understand the complete process of treatment of pertinent data of oceanographic probes (CTD), and to use at an intermediate user level programs of generation of charts and analysis of the oceanographic information such as Ocean Data View and the Seabird proprietary Seabird system.	A3	C4	D1	
	A4		D2	

Contents	
Topic	
Sea Temperature	Horizontal and vertical distribution of temperature. Temperature measurement at the sea. Termistors. Temperature sensors
Sea Salinity	Horizontal and vertical distribution of the salinity. Measurement of sea salinity. Salinity sensors.

Sea surface circulation	Methods of measurement of the sea surface circulation. Geostrophic approximation. Current meters
Light radiation and thermal balance	How to measure light irradiance at the sea. Computing light attenuation in the water column. Method to determine light absorbance by the water, and dissolved or particulate matter I. Computation of a simple thermal balance.
Wind Waves	Sea wave velocity, height and period. Diagrams of waves. Approximation of a train of waves to the coast. Influence of the bathymetry.
Tides	Mechanisms of measurement of the level of the sea. Newton Equilibrium tide theory. Dynamic tides. Dynamic models. How to compute FPM in a particular point on the earth surface
Sound and speed of sound in the sea	Sea sound velocity estimation. Influence of diverse parameters (temperature, salinity, pressure). Vertical sound profiles. Sound reflection and refraction. Sound channels.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	18	45	63
Seminars	14	28	42
Studies excursion	4.75	2	6.75
Practices through ICT	16	10.75	26.75
Objective questions exam	3	0	3
Essay questions exam	2.25	0	2.25
Problem and/or exercise solving	2.25	0	2.25
Report of practices, practicum and external practices	0	4	4

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	The lecturer will give an insight of the main subjects treated during the course.
Seminars	Student work on subjects and exercises brought by the teachers. Data come from the real world and the discussion can either individual or in small groups. A questionnaire must be solved at the end of each session
Studies excursion	Cruise to practise the different instruments (CTD, light, Lagrangian buoys, ADCP, etc) used in the physical oceanography. This cruise has compulsory character in the modality of continuous evaluation as well as in the modality of global evaluation
Practices through ICT	Practices aiming to solve actual oceanographic problems using instruments and software such as Seabird data processing and Ocean Data View. These practical are compulsory in the modality of continuous evaluation as well as in the modality of global evaluation

Personalized assistance

Methodologies	Description
Lecturing	Master class. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation. Tutorial sessions will be also available by electronic means, videoconference or FAITIC forums if previously agreed
Seminars	At the beginning of every seminar, the teacher will describe the objectives and purpose of the seminar. The students will have a guide on the TEMA platform describing all the exercises and questions required. The exercises can be solved individually or in small groups, but a personalised report is required. At the end of this seminar a 15 minute multiple option quest will be fulfilled.
Studies excursion	The teacher will describe the tasks to do, explain the different instruments and technique, and monitors the students' use of such instruments
Tests	Description
Objective questions exam	A multiple option test to calibrate the students' knowledge, always closely related to what was done during seminars, classroom practical work, etc.
Essay questions exam	An examen to validate the general knowledge of the student.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	During the seminars the student will be asked to solve several theoretical and practical subjects taken from real cruises/data. At the end of the seminar a questionnaire must be solved (and evaluated)	20	A2 C3 D5 A3 C4 A4
Studies excursion	After the cruise a report is required and evaluated	5	A3 C4 D1
Objective questions exam	Three questionnaires of objective questions of individual resolution are requested during the course. All must be done in Moovi. The first proof consists in questions that are presented along the development of the theoretical lessons (10% of the total note) and can be completed anytime along the course before the final exam. The second questionnaire tests the knowledge obtained in the practices sessions (except the cruise which has his own report); it opens in Moovi at the end of the practices and remains opened until the examination of questions of development (15% of the total note). The last test values the global knowledges of the OFII subject and has to be done anytime after the end of the masterclasses but before the final examination (10% of the total qualification)	35	C4
Essay questions exam	Questions and exercises to value the understanding, capacity of analysis, synthesis and knowledges purchased. This exam must be approved with a minimum of 5 points out of 10	40	A2 C4 A3

Other comments on the Evaluation

It is necessary to obtain a minimal qualification of 5 in the final examination and in the questionnaires derived of the seminars to approve the subject. The questionnaires derived from the seminars can be repeated once, and the final qualification will be the average of the two instances. The cruise report, the questionnaires associated to the practices and the small questions presented in the theoretical lessons do not require a minimal qualification

Qualifications obtained in the objective questions tests are kept during two academic courses (the current one and the next). Happened this term, the student will have to redo the objective questionnaires.

Global assessment option: The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start. Given the experimental nature of the practices, attendance at them is mandatory to be eligible for this evaluation option. **Failure to attend the practices, with no justified cause invalidates this possibility, as well as the opportunity for extraordinary evaluation (2nd opportunity).**

The official exam dates can be obtained at: <http://mar.uvigo.es/alumnado/examenes/>

Students are strongly requested to fulfil a honest and responsible behaviour. It is considered completely unacceptable any alteration or fraud (i.e., copy or plagiarism) contributing to modify the level of knowledge and abilities acquired in exams, evaluations, reports or any kind of teacher's proposed work. Fraudulent behaviour may cause failing the course for a whole academic year. An internal dossier of these activities will be built and, when reoffending, the university rectorate will be asked to open a disciplinary record

Sources of information

Basic Bibliography

Kirk, J.T.O, **Ligth and photosynthesis in aquatic ecosystems**, Cambridge Press, 2011
Varios autores, **Ocean circulation**, Open University Course Team, 1999
Varios autores, **Waves, tides and shallow-water processes**, 2, Open University Course Team, 1999
Pond, S y Pickard, GL, **Introductory Dynamical oceanography**, 3, Pergamon Press, 1991
Pickard, GL y Emery, W, **Descriptive Physical oceanography**, 6, Pergamon Press, 2011
Sverdrup, HU; Johnson, MW y Fleming, RH, **The Oceans. Their physics, chemistry and general biology**, 2, Prentice-Hall, 1946
Varela, R y Rosón, G, **Métodos en oceanografía Física**, 1, Anthia., 2008

Complementary Bibliography

Beer, T, **Environmental Oceanography. An introduction to the behavior of coastal waters**, Pergamon Press, 1983
Newman, G y Pierson, Jr, WJ, **Principles of Physical Oceanography**, Prentice-Hall, 1966
Kennish, MJ, **Practical handbook of Marine Science**, 3, CRC Press, 2001

Recommendations

Subjects that are recommended to be taken simultaneously

Geological oceanography II/V10G061V01308

Subjects that it is recommended to have taken before

Physical oceanography I/V10G061V01302

IDENTIFYING DATA**Geological oceanography II**

Subject	Geological oceanography II			
Code	V10G061V01308			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Alejo Flores, Irene			
Lecturers	Alejo Flores, Irene Nombela Castaño, Miguel Angel Pérez Arlucea, Marta María			
E-mail	ialejo@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	<p>The subject Geological Oceanography II, intends to train the student in the direct and indirect techniques for the characterization of the submarine bottoms, as well as the geological record in marine environments of continental shelf and deep environments (continental slope, continental abyssal plains, dorsal flanks , Ridges and ocean trenches). Therefore this subject has a different approach to the one of the Geological Oceanography I dedicated to the coastal and coastal areas. It is intended therefore that the student acquire the knowledge in the use and application of the latest generation techniques in sea surveys, as well as the ability to plan and develop oceanographic geological field works and prepare and submit reports.</p> <p>Students are required to take this course in responsible and honest behavior.</p> <p>Any form of fraud (i.e. copy and/or plagiarism) intended to falsify the level of knowledge or skill attained by a student in any type of test, report, or work designed for this purpose is considered inadmissible. This fraudulent conduct will be sanctioned with the firmness and rigor that establishes the current regulation.</p> <p>English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.</p>			

Training and Learning Results

Code	
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
B2	Plan and execute surveys in the field and laboratory work, applying basic tools and techniques for sampling, data acquisition and analysis in the water column, sea bottom and marine substratum.
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.
B5	Develop, implement and write basic or applied projects in oceanography from a multidisciplinary perspective.
C13	Acquire the basic sedimentological, geochemical and geophysical techniques and methodologies used in identification, use and sustainability of the natural resources of coastal and marine environments.
C14	Know basic concepts and events of global change obtained from geological records.
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.

Expected results from this subject

Expected results from this subject	Training and Learning Results			
1. Get skills to plan and carry out geological oceanography surveys	A3	B2	C13	D5
2. Get familiar with oceanographic databases in public repositories	A3	B4	C14	D1
3. To know the basic methods of geophysical exploration	A3	B2 B4	C13 C14	D5
4. To know the basic techniques of compositional analysis and physical properties of sedimentary cores	A2 A3	B2 B4	C13 C14	D5
5. To know and apply the techniques of geochemical characterization in sediments.	A2	B2 B4	C13 C14	D1 D5
6. Get familiar with geophysical and geochemical data processing methods	A3 A4	B4	C13	D1

7. Get skills to write and submit reports	A2	B4	C14	D1
	A3	B5		
	A4			
8. Security during the execution of an oceanographic survey	A2	B2	C13	D5

Contents

Topic	
THEMATIC UNITY I-: INTRODUCTION TO THE MARINE GEOLOGICAL RESEARCH IN THE SEA	THEME 1.- Introduction to the subject Geological Oceanography II. Introduction to the geological oceanography technologies applied to the study of shelf and deep sea environments. Presentation of public data repositories.
THEMATIC UNITY -II-: POSITION SYSTEMS IN THE SEA	THEME 2.- Topic to select a position system. Global position systems and integration with acoustic position systems.
THEMATIC UNITY III-: ACOUSTIC SYSTEMS IN DEEP SEA	THEME 3.- Acoustic underwater and sonar systems. THEME 4.- Sidescan Sonar
THEMATIC UNIT IV-: MARINE SEISMIC SURVEYING	THEME 5.- Marine Seismic surveying: conceptual aspects. THEME 6.- Description of the diferents equipment and collected records
THEMATIC UNIT V-: MARINE GRAVIMETRY SURVEYING	THEME 7.- Gravimetry surveying and its application to marine research.
THEMATIC UNIT -VI-: MARINE MAGNETIC SURVEYING	THEME 8.- Magnetic surveying and its application to marine research.
THEMATIC UNIT-VII-: MARINE GEOTHERMAL FLOW	THEME 9.- Geothermal flow and its application to marine research.
THEMATIC UNIT -VIII-: ELECTROMAGNETIC AND RADIOMETRIC SURVEYING IN MARINE ENVIRONMENTS	THEME 10.- Electromacnetic and radiometric surveying and its application to marine research.
THEMATIC UNIT IX-: SAMPLING SEDIMENTS AND ROCKS METHODS IN SHELF AND DEEP SEA ENVIRONMENTS.	THEME 11.- Sampler methods for Particulate Suspended Matter and bottom sediment samples at deep environments.
GEOTHECNICS TECHNIQS	THEME 12.- Deep sea coring technics. methods. Ocean Drilling Projects. THEME 13.- Geophysical observation into the corers.
THEMATIC UNIT X-: OCEANOGRAPHY INFRAESTRUCTURES	THEME 14.: Sampler platforms in geological oceanography. THEME 15: New technology in submarine observatoties.
THEMATIC UNIT -XI-: PLANNING OCEANOGRAPHIC SURVEYS	THEME 16.: Project and planification of oceanographic surveys.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	24	48	72
Laboratory practical	15	16	31
Mentored work	2	13	15
Seminars	5	12	17
Field practice	5	6	11
Objective questions exam	1	0	1
Objective questions exam	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Introductory activities	Detailed introduction about the content of the subject and the methodology followed aswell as the form of evaluation, field trips, practical classes and seminars. The materials neccesary to follow lecturesrs ans practical sessions and references will be presented.
Lecturing	This include the theoretical contents about all methods used in Oceanography Geology surveys, including selected aplicated examples. The student will be evaluated about this content in a final exam.
Laboratory practical	Laboratory practices consist of three thematic blocks divided into 5 sessions: 1- Corer description and interpretation. 2- Introduction to the interpretation of seismic records: reflection and refraction systems. 3- Data processing, with an specific software, for the elaboration of bathymetric maps (the computer classroom will be used). Attendance is MANDATORY.

Mentored work	<p>In groups of two or three students, the students will choose a applied scientific study on the subject for an oral presentations.</p> <p>The student will show there ability to work as a team and his ability to make an oral presentation on a scientific topic. In the ensuing discussion, the capacity for synthesis and understanding of the proposed topic will be evaluated.</p> <p>The activity is MANDATORY.</p>
Seminars	<p>The seminars that students will have to hold and deliver, consists of three sessions:</p> <p>1- Handling of nautical charts, navigation parameters, point positioning and sampling path. Key tools for the preparation and conduct of oceanographic surveys.</p> <p>2- Interpretation of Side Scan Sonar records.</p> <p>3- Exhibition of examples of studies applied in Geological Oceanography, focusing into the specific methodology used for each specific work. Debate and analysis of the topic presented.</p> <p>These activities are MANDATORY.</p>
Field practice	<p>There will be a session onboard the B/O Mytilus along the Ria de Vigo were the student will participate in a oceanographyc survey. The objetive is to be able to familiarize themselves with the systems of acquisition of submarine acoustic data and of marine sediment samples (sediment cores, dredgers, etc.).</p> <p>It is also intended that they become familiar with the organization and procedure of an oceanographic survey, for which smaller groups of work will be created to carry out the activity on board the oceanographic vessel. At the end of the activity, each group will have to produce a "cruise report".</p> <p>Some of the collected data will be worked out in practical sessions.</p> <p>The activity is MANDATORY.</p>

Personalized assistance

Methodologies	Description
Introductory activities	<p>This first part corresponds to the presentation of the subject: activities that will be developed along the course, material that will be needed, and to specify the deliverables that the students will have to present along the course. The evaluation system to be followed will also be presented. The active participation of the students will be encouraged, basically aimed at clarifying all the doubts related to the approach and development of the subject. Students are invited to contact the teacher to clarify doubts at all times, preferably in person, individually, or in a group. It is necessary to contact the teacher sufficiently in advance by email or using the virtual secretary.</p>
Lecturing	<p>The active participation of the students in the classes will be encouraged, encouraging the discussion and approach of small questions to be solved in class. The student can contact at all times with the teacher to clarify doubts, in person, individually, or in a group. If the doubts require greater personal attention to solve problems they can ask for personalized tutorials. It is necessary to contact the teacher sufficiently in advance by email or using the virtual secretary.</p>
Laboratory practical	<p>The exercises presented in the three Practical blocks will be solved in the same classroom in order to resolve the doubts gradually as they arise as the work progresses in the complexity of the exercises. The active participation of students will be encouraged. Each practice will have a deliverable for evaluation. Once completed, the student can contact at all times with the teacher to clarify doubts, preferably in person, individually, or in a group. If the doubts require greater personal attention will be agreed a tutorial to solve problems. It is necessary to contact the teacher sufficiently in advance by email or using the virtual secretary.</p>
Field practice	<p>An oceanography Survey will be carried out in the B/O Mytilus, in groups of 5-6 students, where they will put into practice the methodology involved in Geological Oceanography cruises. Some of the data collected on board will be worked out in practical sessions. After the activity, each group of students must produce a survey report to be evaluated. This will include: a description of the methodology achieved and collected data. Students who wish may attend personalized tutorials to resolve doubts. Contacting the teacher sufficiently in advance by email or using the virtual secretary is necessary.</p>
Mentored work	<p>In groups of two or three persons, students will choose a current publication that shows an applied practical work of any of the equipment and methodologies that are included in the assignment. They will have to give their colleagues an oral exposition of the work and present a written paper in an article format. Students who wish may attend personalized tutorials to resolve doubts. Contacting the teacher sufficiently in advance by email or using the virtual secretary is necessary.</p>
Seminars	<p>The practical exercises presented in the different seminars sessions will be solved in the same classroom in order to resolve the doubts gradually as they arise as the work progresses in the complexity of the exercises. The active participation of students will be encouraged. Once completed, the student can contact at all times with the teacher to clarify doubts, preferably in person, individually, or in a group. If the doubts require greater personal attention, a tutorial to solve problems will be agreed upon. Contacting the teacher sufficiently in advance by email or using the virtual secretary is necessary.</p>

Assessment

	Description	Qualification	Training and Learning Results			
Laboratory practical	Attendance at the laboratory practices is MANDATORY. The correct implementation of the exercises proposed in these practices will be evaluated.	15	A2 A3	B2 B4	C13 C14	D1
Mentored work	The assignment of individual or paired work will be evaluated, assessing both the preparation of the topic, the presentation of a summary document of the subject as well as the presentation of the same. This activity is MANDATORY	15	A2 A3 A4	B5	C13 C14	D1
Seminars	Seminar attendance is MANDATORY. The correct implementation of the exercises proposed in these seminars will be evaluated.	10	A2 A3	B2 B4	C13 C14	D1
Field practice	Attendance at the sea survey is MANDATORY. The correct implementation of the exercises proposed in these practices will be evaluated.	10	A2 A3	B2 B4 B5	C13	D5
Objective questions exam	Questions and exercises to assess understanding, analytical capacity and synthesis of acquired knowledge, mainly in relation to the content of the first thematic blocks of the master classes. It will be done throughout the course.	10	A2 A3 A4	B2 B4 B5	C13 C14	D1 D5
Objective questions exam	Questions and exercises to assess understanding, analytical capacity and synthesis of acquired knowledge, mainly in relation to ALL the content of the theoretical classes. This exam will coincide with the 1st chance official date.	40	A2 A3 A4	B2 B4 B5	C13 C14	D1 D5

Other comments on the Evaluation

Continuous assesment option

It will be **necessary to obtain a minimum of 5 points (out of 10)** in all the Methodologies/Tests to carry out the weighting and pass the subject.

Global assessment option

The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start. Given the experimental nature of the practices, seminars and studies excursion, attendance at them is mandatory to be eligible for this evaluation option. **Failure to attend any of this activities, with no justified cause invalidates this possibility, as well as the opportunity for extraordinary evaluation (2nd opportunity).**

Second opportunity assesment (July)

Exams of each of the Items NOT passed in the 1st opportunity evaluation.

Date, time and place of exams will be published in the official web of Marine Sciences

Faculty: <http://mar.uvigo.es/index.php/en/alumnado-actual-2/examenes-3>

Others considerations

Students are strongly requested to fulfil a honest and responsible behaviour. It is considered completely unacceptable any alteration or fraud (i.e., copy or plagiarism) contributing to modify the level of knowledge and abilities acquired in exams, evaluations, reports or any kind of teacher's proposed work. Fraudulent behaviour may cause failing the course for a whole academic year. An internal dossier of these activities will be built and, when reoffending, the university rectorate will be asked to open a disciplinary record

Sources of information

Basic Bibliography

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McQuilling, R., Bacon, M., Barclay, W., **An Introduction to seismic interpretation**, Graham & Trotman, 287 pp.,

Complementary Bibliography

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Telford, W.M.; Geldart, L.P., Sheriff, R.E., **Applied Geophysics, 2nd Edition.**, Cambridge University Press, 770 pp.,

Trabant, P.K., **Applied High-Resolution Geophysical Methods Offshore Geoengineering Hazards.**, D. reidel Publishing Company. International Human Resources Development Corporation. Boston., 265 p.,

Udias, A., Mézcua, J., **Fundamentos de Geofísica**, Ed. Alhambra. 419 pp.,

Wille, P. C., **Sound images of the Ocean in Research and Monitoring.**, Springer-Verlag, 471,

OpenCourseWare, <http://ocw.mit.edu/index.htm>,

Recommendations

Subjects that continue the syllabus

Basin Analysis/V10G061V01406

Applied marine geology/V10G061V01403

Subjects that are recommended to be taken simultaneously

Physical oceanography II/V10G061V01307

Subjects that it is recommended to have taken before

Geology: Geology 1/V10G061V01103

Geology: Geology 2/V10G061V01108

Coastal and marine sedimentary habitats/V10G061V01207

Sedimentology/V10G061V01205

Geological oceanography I/V10G061V01303

IDENTIFYING DATA				
Chemistry applied to the marine environment II				
Subject	Chemistry applied to the marine environment II			
Code	V10G061V01309			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Moldes Moreira, Diego Nieto Palmeiro, Óscar			
Lecturers	Calle González, Inmaculada de la Costas Rodríguez, Marta Moldes Moreira, Diego Nieto Palmeiro, Óscar			
E-mail	diegomoldes@gmail.com palmeiro@uvigo.es			
Web	http://mar.uvigo.es			
General description	<p>The student will acquire competences and skills on several topics of chemistry in the marine environment. In the first part of the subject, students will tackle important applications such as wastewater treatment, desalination and marine biotechnology.</p> <p>In the second part, students will acquire theoretical and practical competences regarding the analysis of chemical contaminants as well as other compounds of interest in the marine environment. In this case they will learn to use simple techniques for sample preparation prior to the measurement step and their applications in the compartments of the marine environment. The students will get knowledge about the relevance of chemistry regarding the marine environment.</p> <p>English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.</p>			

Training and Learning Results				
Code				
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues			
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences			
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy			
B1	Know and use vocabulary, concepts, principles and theories related to oceanography and apply everything learned in a professional and/or research environment.			
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.			
C6	Acquire the fundamentals and terminology of chemical processes.			
C7	Apply to the marine and coastal environment the principles and methods used in Chemistry.			
C8	Know the main pollutants, their causes and effects in the marine and coastal environment.			
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.			
D2	Acquire the ability to learn autonomously, continuously and collaboratively, organizing and planning tasks over time.			
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.			

Expected results from this subject				
Expected results from this subject	Training and Learning Results			
Recognise the main characteristics of the wastewater. Classify the wastewater depending on their origin.	A3		C6 C8	
Knowing the main technologies used for wastewater treatment and choosing the suitable one depending on the wastewater properties.	A3	B1	C6 C7	
Elaborate scientific documents with own data obtained by means of a simulation software	A3 A4 A5	B1 B4	C6 C7 C8	D1 D2
Recognise the main methodologies of sea water desalination	A3 A4	B1	C6 C7 C8	D5

Knowing the potential of the marine environment as a source of marketable products by means of biotechnological processes	A3 A4 A5		C6	
Enumerate the most important points regarding the setup of a control plan about marine pollution.	A4 A5	B1 B4	C6 C8	D2 D5
Choose and use the suitable material for sediments sampling. Choose the most important sentinel organisms for studying marine pollution.	A3 A4 A5		C6 C7 C8	
Apply the suitable chemical analytical techniques for the most interesting compounds in Environmental Chemistry. Knowing the suitable experimental conditions for the determination of a chemical compound depending on the selected technique.	A3 A4 A5	B1 B4	C6 C7 C8	D1
Being able to determine the concentration of a chemical compound in the marine environment depending on the analytical technique employed.	A3 A4 A5	B4	C6 C7 C8	D1 D2
Apply the fundamental concepts of quality control in an analytical laboratory.	A3 A5	B4	C7	D1

Contents

Topic	
Wastewater treatment	Sources and classification of wastewaters. Physical, chemical and biological properties of wastewater. General operation of a wastewater treatment plant (WWTP). Pretreatment and primary treatment. Secondary treatment: aerobic and anaerobic systems, suspended and fixed biomass systems. Tertiary or advanced treatment.
Desalination of seawater	Technologies of desalination: thermal processes and processes with membranes. Environmental effects.
Marine biotechnology	Definition and importance of biotechnology. General diagram of biotechnological production. Procedures to obtain biotechnological products from marine organisms (biofuels, pharmaceutical products, biorremediation of pollutants)
Chemical analysis of pollutants in the water column, sediments and marine organisms.	Sampling methods. Methods for sample preparation and determination in the water column. Extraction, purification and determination methods of pollutants in sediments and marine organisms.
Analysis of marine biotoxins.	Chemical structure of marine biotoxins. Toxicity of marine biotoxins. Sample preparation. Methods of separation and detection.
Control and guarantee of quality in the measures.	Systems of guarantee of quality. Validation of analytical methods. Intercomparison assays.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2	3
Lecturing	20	30	50
Problem solving	2	10	12
Mentored work	7	21	28
Laboratory practical	10	10	20
Practices through ICT	5	1	6
Studies excursion	5	1	6
Presentation	0.5	1.5	2
Objective questions exam	2	4	6
Essay	0	12	12
Report of practices, practicum and external practices	0	2	2
Problem and/or exercise solving	1	2	3

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Introductory activities	The syllabus will be presented to the students (mainly aims, competences and evaluation criteria). Moreover the activities of the semester will be presented..

Lecturing	The professor will make an exhibition of the contents of the syllabus to develop, where the professor can pose some question to the students for his resolution in class. Likewise, the students can ask to the professor the questions that go arising along the exhibition. The material of the presentation will be available for the students before the session and will have to assist to her with said material. At the end of each subject, or of each group of subjects, will have to make a questionnaire that will resolve individually.
Problem solving	During the problem solving sessions, the teacher will explain the calculations to be made on a series of problems to calculate the concentration of a chemical contaminant in samples of biota and/or marine sediments.
Mentored work	During the session of computing practice, the students will obtain data related with the wastewater treatment. With these data the students will write a report with the same format of a scientific article. On the other hand, the students will study a practical case based in the analysis of a contaminant based on a bibliographic research.
Laboratory practical	The students will make some lab practices regarding the analysis of environmental pollutants and will present the corresponding report.
Practices through ICT	The students will make some practices of computer on the treatment of residual waters. They will consist in the utilisation of a simulator in which it will study the effect of diverse parameters in the process of treatment of the residual waters. The students will have to take data of the different parameters studied, which will be employed for the preparation of the Supervised Works.
Studies excursion	A visit to a wastewater treatment facility will be carried out. After the visit the students will answer to a brief questionnaire. Considering the economic possibilities of the centre, schedules and availability of companies of interest, the students could visit other company of interest related with the subject. The attendance to this visit wouldn't be mandatory.
Presentation	The students will do a brief presentation in public related with the analytical work made in the Supervised Works. The mates and the professor will be able to make questions on the presentation made.

Personalized assistance

Methodologies	Description
Introductory activities	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Mentored work	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Presentation	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Laboratory practical	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Practices through ICT	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Studies excursion	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Lecturing	Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Problem solving	

Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practical	The accurate work of the student, the attitude to learn and the correct employment of the lab material will be assessed.	2.5	A5	B4	D2
Studies excursion	The students will visit a wastewater treatment facility. After that, a brief questionnaire must be answer.	5	A3	C6	
Presentation	The students will do a brief public presentation related to the guided work derived from the seminar sessions.	2.5	A3	B1	D2
			A4		

Objective questions exam	Diverse quizzes of theoretical content and practical/theoretical content derived from the masterclasses will be made. These exams may contain type test questions, problems resolutions and/or questions with open answers	37.5	A3 A4 A5	B1 B4 C8	C6 C7 C8	D1 D5
Essay	A scientific article must be written by the students. The data will be obtained by means of a wastewater simulation software. This counts for 20% of final evaluations. Moreover, a guided work must be carried out during/after the seminar sessions. This counts for 10% of final evaluation.	30	A3 A4 A5	B1 B4 C8	C6 C7 C8	D1
Report of practices, practicum and external practices	The students will present an original report of the results obtained in the lab practices	10	A3 A4 A5		C6 C7 C8	D1 D2
Problem and/or exercise solving	The problems will consist in calculating the concentration of a chemical contaminant, from the data normally obtained in a laboratory work, and expressing the result with the correct significant units and figures. The result obtained shall be evaluated, as well as the clarity and reasoning used to arrive at it. The final examination will consist in solving two such problems.	12.5	A4 A5	B1 B4	C6 C7	D1

Other comments on the Evaluation

Date, time and place of exams will be published in the official web of Marien Ciencias Faculty:

<http://mar.uvigo.es/alumnado/examen.es/>

To pass the subject, students have to achieve a minimum of 5 points up to 10 in each one of the qualified activities.

The activities with a lower qualification than 5 points will be repeated in the final exam.

The reports of practices, works and projects that do not reach the minimum qualification, will have to send with the timely corrections in the term that will estimate the lecturers in each case.

The realisation by part of the student of any proof of which show previously will be taken into account immediately for the final qualification and will be recorded in the record like student presented in the corresponding announcement.

An absence to one of the sessions of seminars or practical supposes the no evaluation of that qualified activity and will be repeated on next year.

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K. Grasshoff, K. Kremling, M. Ehrhardt, **Methods of Seawater Analysis**, 3, Wiley-VCH, 1999

Fifield F.W., Haines P.J., **Environmental Analytical Chemistry**, Blackie Academic, 1995

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Recommendations

Subjects that it is recommended to have taken before

Chemical oceanography I/V10G061V01204

Chemical oceanography II/V10G061V01209

Chemistry applied to the marine environment I/V10G061V01304

IDENTIFYING DATA				
Aquaculture				
Subject	Aquaculture			
Code	V10G061V01310			
Study programme	Grado en Ciencias del Mar			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Rocha Valdes, Francisco Javier			
Lecturers	Rocha Valdes, Francisco Javier			
E-mail	frocha@uvigo.es			
Web	http://https://mar.uvigo.es/			
General description	<p>This course aims to provide to the students with the knowledge, skills and abilities that enable their to conceive, design and carry out research projects in the field of aquaculture. At the same time, this matter allows the student to design, manage and control aquaculture farming facilities on land and sea.</p> <p>English Friendly subject: International students may request from the teachers:</p> <p>a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.</p>			

Training and Learning Results

Code	
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B3	Recognize and implement good practices in measurement and experimentation, and work responsibly and safely both in field surveys and in the laboratory.
B4	Manage, process and interpret the data and information obtained both in the field and in the laboratory.
C8	Know the main pollutants, their causes and effects in the marine and coastal environment.
C11	Apply the knowledge and techniques acquired to the characterization and sustainable use of living resources and marine ecosystems.
D1	Develop the search, analysis and synthesis of information skills oriented to the identification and resolution of problems.
D5	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Knowing the potentially cultivable marine species in the world	A3	B3 B4	C11	D1 D5
Know the aquaculture installations in land and sea	A2	B3 B4	C11	D5
Dominate the aquaculture auxiliary techniques (phytoplankton and zooplankton) and the culture technics of the main species that are cultivate now in Europe	A2	B3 B4		
Know the treatments for the water in the culture systems	A3	B3	C11	D1 D5
Recognise and analyse problems and propose solution strategies	A2 A3	B3 B4	C11	D1 D5
Identify and control problems of environmental impact and marine pollution caused by marine aquaculture	A2 A3 A5		C8	D1 D5
Design, control and management of culture centres and recovery of marine endangered Species	A2 A5	B3 B4	C11	D5
Known the operational details of marine companies, recognise specific problems and propose solutions	A3			D5
Design, control and manage culture production plants	A2			D1 D5
Aquariology	A2	B4		D1

Contents

Topic	
INTRODUCTION	Objectives of aquaculture. History, current situation and perspectives in the world and in Spain. Types of cultivation: according to species and its stages, according to its characteristics. New farming systems.
SPECIES SELECTION CRITERIA	Introduction. Biological criteria (reproductive, productive and health characteristics). Commercial criteria (consumption and market). Cultured freshwater species. Farmed marine species. Potentially cultivable species.
FACILITIES	Types of Facilities. Water intake. Storage and settling tanks. Culture tank design. Pond designs for culture. Floating cages, rafts, long-line. Auxiliary equipment.
WATER QUALITY AND ITS CONTROL	Sea water as culture medium. Changes suffered by the water in the crop. Biological filtration. mechanical filtration. physical absorption. Disinfection. Decantation. Aeration. Water quality criteria for aquaculture.
FOOD AND NUTRITION	Introduction. Feeding modes (larval, juvenile and adult stages). Nutrient requirements (molluscs, crustaceans, fish). Types of feed used in aquaculture. Formulation of diets.
PHYTOPLANKTON CULTURE	Introduction. Optimal properties for the choice of a cultivable species of phytoplankton. physical requirements. Nutrient requirements. Culture media. Characteristics of growth in culture. Phytoplankton culture methods.
ZOOPLANKTON CULTURE	Introduction. Artemia culture: general characteristics, life cycle, culture methodology, use in aquaculture. Rotifera culture: general characteristics, life cycle, culture methodology, use in aquaculture. Other planktonic crustaceans used in aquaculture: Copepods, Cladocera.
MOLLUSKS FARMING	Clam culture: obtaining and transporting broodstock, conditioning and obtaining gametes, embryo culture, larval culture, natural seed capture, post-larvae culture, pre-growing, fattening. Differences in the cultivation of other species. Octopus culture: obtaining and transporting broodstock, conditioning and obtaining eggs, embryo culture, larval culture, post-larvae culture, fattening and production.
ECHINODERMS FARMING	Introduction. Hedgehog Cultivation: Conditioning of reproducers and obtaining spawns; embryonic and larval culture, culture of postlarvae, pre-fattening, fattening. Other echinoderms farmed in Aquaculture.
CRUSTACEAN FARMING	Shrimp culture: obtaining and transporting broodstock, conditioning and obtaining gametes, embryo culture, larval culture, post-larvae culture, pre-fattening, fattening. Cetaria and their characteristics.
FISH FARMING	Turbot culture: obtaining and transporting reproducers, conditioning and obtaining gametes, embryo culture, larval culture, weaning, pre-fattening, fattening. Bream culture: obtaining and transporting broodstock, conditioning and obtaining gametes, embryo culture, larval culture, weaning pre-fattening, fattening. Seabass farming: obtaining and transporting broodstock, conditioning and obtaining gametes, embryo culture, larval culture, weaning pre-fattening, fattening. Salmon farming: obtaining and transporting broodstock, conditioning and obtaining gametes, embryo culture, larval culture, weaning pre-fattening, fattening.
MACROALGAE FARMING	Introduction on the cultivation of macroalgae, advantages and characteristics. cultivated species. Culture systems and methodology.
DISEASES OF CULTIVATED SPECIES	Mortality. Prevention: vaccinations, disinfection and isolation of specimens. Treatments: medications, environmental manipulation, isolation and disposal. Animal examination. Viral diseases. Bacterial diseases. Fungal infections. Protozoan diseases. Metazoan diseases.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	30	45	75
Seminars	7	14	21
Laboratory practical	15	15	30
Seminars	2	0	2
Studies excursion	7	0	7
Essay questions exam	3	7.5	10.5
Objective questions exam	1	1.5	2.5
Report of practices, practicum and external practices	0	2	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Program contents will be explained through classes. During the sessions the students will encourage the realization of comments and questions for clarification of questions during class. For the classes preparation by the students, notes on each of the topics will be available on the platform Tem@ before classes begin.
Seminars	Each group will prepare a seminar topic related to aquaculture, which will be presented and discussed in groups. Similarly, each group should prepare a brief abstract on the subject matter to be placed on the platform Tem@. This abstract will be distributed among all students and will be evaluated in the test.
Laboratory practical	This is obligatory because it is an essential complement to the theoretical sessions. Laboratory practices will be used to explain the techniques of cultivation and laboratory culture. To take full advantage of these practices, the student will write a resume for each practice. Text will include all possible information about this activity, including the theoretical foundation, the purpose of practice and job description to be held.
Seminars	During the tutorials it will be discussed questions concerning any aspect of the subject. Moreover, as this matter is attended in the last year of the degree, this tutoring time may also be used by students to see career or incorporation into different graduate curricula related to aquaculture.
Studies excursion	It is planned to conduct two studio outputs, aimed at students to observe the practical application of knowledge taught in class. The outputs shall be performed: <ol style="list-style-type: none"> 1. Visit the farmed salmon in Cotobade (Pontevedra). 2. Site visit of the Galician Institute for Aquaculture Training of the Galician Government in the Island of Arousa.

Personalized assistance

Methodologies	Description
Seminars	These activities will be developed in small groups. Students can obtain help and guidance to guide them in the seminar preparation and learning process. These activities will be developed in person (by direct consultations in the classroom or during tutorials and consultation sessions in the teacher's office) or via email.
Seminars	These activities will be developed individually or in small groups. Its purpose will be to meet the needs and queries of students related to the study, topics related to the subject and correction of exams, providing guidance, support and motivation in the learning process. These activities will be developed in person or via email. The tutorials, both individual and group, will be held from Monday to Thursday from 11:30 to 12:30 a.m. Students willing so could attend personal tutorials to solve doubts and/or uncertainties, which will mainly take place during the timetables indicated. To better optimise the procedure, the student is requested to previously contact his/her teacher with reasonable anticipation
Tests	Description
Essay questions exam	For the preparation of the tests, students may consult questions or clarify aspects of the subject that are evaluated in the exam. The assistance will be developed in person (by direct consultations in the classroom or during tutorials and consultation sessions by the teacher in his office) or via email. Similarly, once the test has been completed, the students will have a consultation schedule and review of exams to solve doubts and make inquiries about the exam itself.
Objective questions exam	The tests will be developed weekly with the objective that the students prepare each week the subject that will be discussed during the sessions. For the preparation of the tests, students may consult questions or clarify aspects of the subject that will be evaluated in the exam. The assistance will be developed in person (by direct consultations in the classroom or during tutorials and consultation sessions by the teacher in his office) or via email.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	Following the completion of the seminars, each student group must submit a summary report of the subject matter, which will be evaluated. A minimum of 5 will be required to approve.	10	A2 B4 D1 A3 D5 A5
Laboratory practical	Laboratory practices are considered an essential part of the subject. Practices will be evaluated by the attendance and assistance of students to them. Laboratory practices are an obligatory activity.	5	A5 B3 C8 B4
Essay questions exam	There will be a long written test on the official date which will be assessed on the knowledge gained throughout the course. This test will assess all the knowledge acquired in the course of the subject. The minimum grade to pass the exam will be 5	40	A2 B4 C11 D5 A3

Objective questions exam	There will be several quizzes, multiple choice, during the course of lectures. Since the objective of these tests is that students prepare in advance the subjects to be discussed, questions of each test will cover the topics that are being treated that week (including topics to be covered in that class or the next if they are part of issue). The minimum grade to pass the test will be 5.	15	A2 B3 A3 B4 A5	D1
Report of practices, practicum and external practices	For the evaluation of practices is obligatory that each student prepare a written report on the implementation and results of laboratory practices, which will be evaluated. The minimum grade to approve the report will be 5.	30	A2 B3 A3 B4 A5	D1 D5

Other comments on the Evaluation

In order to pass the subject, each student **must approve** the evaluation of teaching (long answer test) and laboratory practices (attendance and practice report) **separately** (with a mark higher than 5).

In the case of laboratory practices, which are mandatory, failure to attend these practices that is not duly justified will mean the elimination of the option to take the second chance test. Obviously, if the student has attended the practices, but has not passed them, they will have the right to recover them through a job and attend the second chance test if necessary.

The application for this evaluation option must be submitted in the time and manner determined by the Center, which will be published prior to the academic start.

In the case that the student takes the **second chance evaluation** (July test), the weekly test scores, laboratory practices and seminars will be saved for the estimation of the final qualification in the case that the student exceeds (with note on 5) the exam. If the student passes the second chance exam, the grade will account for 40% of the final grade.

The official calendar of the evaluation will be published in:

<http://mar.uvigo.es/alumnado/examenes/>

Students are strongly requested to fulfil a honest and responsible behaviour. It is considered completely unacceptable any alteration or fraud (i.e., copy or plagiarism) contributing to modify the level of knowledge and abilities acquired in exams, evaluations, reports or any kind of teacher's proposed work. Fraudulent behaviour may cause failing the course for a whole academic year. An internal dossier of these activities will be built and, when reoffending, the university rectorate will be asked to open a disciplinary record.

Sources of information

Basic Bibliography

Barnabe, G., **Bases biológicas y ecológicas de la acuicultura**, 1996,
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 Xunta de Galicia - VV.AA., **Unidades didácticas de acuicultura**, 1991,
 Beveridge, M., **Cage Aquaculture**, 2004,
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 Huguenin, J. E. y J. Colt, **Design and Operating Guide for Aquaculture Seawater Systems**, 2002,
 Lee, D. O. y J. F. Wickings, **Cultivo de crustáceos**, 1996,
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 Wedmeyer, G. A., **Physiology of fish in intensive culture systems**, 1996,
 Wedemeyer, G. A., **Fish Hatchery Management**, 2001,

Recommendations

Subjects that it is recommended to have taken before

Marine zoology/V10G061V01210