FACULTAD DE CIENCIAS DEL MAR Y DE RECURSOS NATURALES

INGENIERÍA CIVIL OCEÁNICA

OFICINA CENTRAL
Edificio Rokamar. 13 Norte 766, 5 piso, Viña del Mar, Chile
Fono: (56) 32-2686848 2687306 (Anexo 500)
Fax: (56) 32-2684385 2690265 (Anexo 508)
www.ingenieriaoceanica.cl

SECRETARIA DE DOCENCIA
Av. Borgoño 16344, Reñaca, Viña del Mar, Chile
Fonos: (56) 32-507851 (56) 32-507824
www.ingenieriaoceanica.cl
ingenieria.oceanica@uv.cl

UNIVERSIDAD DE VALPARAISO

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OCEAN ENGINEERING

FACULTY OF MARINE SCIENCES AND NATURAL RESOURCES
UNIVERSIDAD DE VALPARAÍSO, CHILE

The Faculty of Marine Sciences and Natural Resources of Universidad de Valparaíso was founded as a heritage of the former Institute of Oceanography of Universidad de Chile -founded in 1941- with the mission to contribute to the development of the national marine culture through the activities of investigation, teaching, scientific and engineering support.

Our Faculty has undergraduate programmes in Marine Biology and Ocean Engineering, being a pioneer in the educational field as it first offers the latter programme in Chile. Besides, a series of postgraduate courses are carried out, such as a Master in Oceanography, Master in Port Management and Administration, a Maritime Engineering Diploma and a special Ocean Engineering Programme for professionals working in the maritime area.

The Ocean Engineering group was formed on 2001 as a response to the increasing demands for marine environmental studies, port development projects and coastal civil works in the local market; and therefore focuses its activity in coastal, port and ocean engineering studies and services.

The following prospectus is intended to give a broad view of our academic staff, resources, courses and research activities carried out at the Faculty of Marine Sciences and Natural Resources.

Partial view of the Faculty of Marine Sciences and Natural Resources
at Universidad de Valparaíso, Chile.

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1. ACADEMIC STAFF

The Faculty has around 100 professionals and highly-qualified technicians to participate in the design and sustainable management of the ocean resources, the coastal area and related systems. Our centre provides a focal point for research in coastal processes and engineering, covering a wide range of applied technologies, consultancy and services, such as in-situ measurements and data analysis, numerical modelling and decision support systems applied to coastal areas. Our academic staff is involved in the research of coastal problems from both oceanographic and engineering points of view, thus ensuring qualitative and quantitative approaches to the development of solutions. The directive staff is comprised by the following members:

Ernesto Gómez Araya
Civil Engineer (UTFSM, Chile)
MSc. In Structural Engineering (UTFSM, Spain)

Gerardo Leighton Sotomayor
PhD in Biological Sciences (U. de Granada, Spain)
Marine Biologist (UCV, Chile)

Mario Cáceres Muñoz
PhD. In Physical Oceanography (Old Dominion University, VA, USA, 2001)
MSc. In Oceanography (University of Concepcion, Chile, 1990)
B.Sc. (Navy Polytechnic Academy, 1982)

Patricio Winckler Grez
Civil Engineer (UTFSM, Chile)
MSc. In Environmental Technology (U. Wolverhampton, England)
Master en Coastal and Port Engineering (CEDEX, Spain)

Roberto Prado Fiedler
Dr. Naturwissenschaften (Christian Albrecht Universität Kiel, Germany)
Marine Biologist (U. de Concepción, Chile)

Sergio Bidart Loyola
Industrial Engineer (UTFSM, Chile)
MBA (IEDE, Spain)

Felipe Caselli Benavente
Industrial Engineer (UAI, Chile)
Master in Business Engineering (UAI, Chile)

Mauricio Reyes Gallardo
Civil Engineer (UTFSM, Chile)

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2. RESUORCES

Measuring and data handling technologies for coastal areas are available at our Faculty, including equipment and instruments particularly suited for shallow waters (current meters, flow meters, CTD submersible data loggers, CTD profilers, mareographs, dredging equipment, GPS's, satellite phones, thermometers, anemometers, phmeters, echo sounders, chromatographer, ecosounder, Kjeldhall digester, access to ship-mounted and stationary ADCP's, etc).

Our team is capable of applying numerical models for simulating hydrodynamics, sediment dynamics and coastal changes, water quality in coastal zones, water disturbance in ports and related problems. The Ocean Engineering Group has within its dependencies a maritime engineering numerical modelling laboratory (Labocéano), with various integrated modelling systems oriented to hydrodynamics, sediment dynamics and coastal changes, water quality in coastal zones, water disturbance in ports and related problems, such as:

- SMS 9.0 - Surface-water Modelling System
- CEM 2.01 – Coastal Engineering Manual
- CEDAS 4.01 – Coastal Engineering Design and Analysis System
- MIKE 21 BW – Business Wave Model, developed by Danish Hydraulic Institute
- SMC – Coastal Modelling System developed by University of Cantabria
- AutoCAD – Software for conceptual design through drafting and detailing
- SAP 2000 – Structural and Earthquake Engineering Software

As a recently formed Ocean Engineering Department, we are planning to implement a physical modelling laboratory in the medium term, considering wave and current flumes.

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3. COURSES

The Ocean Engineering degree is a 12 semester undergraduate degree program leading to professional development in coastal, port and environmental engineering, marine consultancy firms and ocean research organizations. The Program Mission is to provide a high quality, broad academic program in ocean engineering including experience and opportunities in applied research, and include the following modules:

Basic Sciences

- Calculus I (Differentiation)
- Linear algebra
- Introduction to Ocean Engineering
- Chemistry
- English
- Calculus II (Integration)
- Linear algebra
- Physics III (Mechanics)
- Informatics
- Coastal geology
- Calculus III (Various variables)
- Differential equations
- Physics II (Electricity and Magnetism)
- Technical drafting
- Advanced calculus
- Statistics and probabilities
- Physics III (Heat and waves)
- Topography and bathymetry
- Fundamentals of electricity
- Numerical analysis
- Thermodynamics

Management and Administration of Port Operations

- Management
- Operations research
- Microeconomics
- Financial systems
- Macroeconomics
- Operations management
- Maritime transport and port operations
- Human resources
- Project evaluation
- Maritime law

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Structural Engineering

- Soil mechanics
- Strength of materials
- Structural dynamics
- Structural analysis
- Steel structures
- Reinforced concrete
- Structural project
- Maritime engineering project
- Construction of maritime works

Hydraulic, Marine and Environmental Engineering

- Oceanography
- Fluid mechanics
- Hydraulics
- Hydro-acoustics
- Wave mechanics
- Environmental management
- Maritime hydraulics
- Design of maritime works
- Hydraulic modelling
- Coastal engineering
- Environmental law

Naval Engineering

- Navigation systems
- Naval stability systems
- Naval architecture

Complementary Subjects

- 2 technical modules (to be chosen by the student)
- 2 general modules (to be chosen by the student)
- Introduction to the thesis work
- Thesis
- Ethics
- Practice work in an organization or company of the area.

The student obtains the **Bachelor degree in Engineering Sciences** after fulfilling the modules until the 8 semester. The student obtains the **Ocean Engineering certificate** after fulfilling all the requirements above mentioned.

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4. RESEARCH ACTIVITIES UV

Diverse research areas in the maritime area have been developed in the Faculty of Marine Sciences and Natural Resources by the Ocean Engineering Group, among which the following are of principal interest:

- Coastal hydrodynamics (wind, waves, tides, tsunami and currents).
- Pollutant dispersion in marine environment.
- Coastal processes for accurate prediction of erosion and accretion problems.
- Coastal structures and engineering.
- Design criteria, site selection, downtime analysis and layout optimization of ports, harbours and marinas.
- Structural analysis and design, plans and specifications of maritime structures.
- Pollutant dispersion on coastal areas and hazard mitigation.
- Environmental Impact Assessment.

Some of the ongoing academic-oriented projects are described as follows. These projects are carried out by undergraduate students as thesis works in partial fulfilment of the requirements for the Ocean Engineering degree, under the guidance of our academic staff.

Assessment of coastal erosion at El Papagayo Beach, Quintero, and proposals for rehabilitation

The project is intended to achieve and maintain a viable beach for the community of Quintero, on a site historically affected by erosion and coastal property damages. The study will include site analysis, assessment of present beach conditions, principal erosion processes, and a comprehensive understanding of user requirements and the environment in which the beach will operate. The development and evaluation of conceptual alternatives will include the determination of design parameters (wind, waves, currents, water levels and quality), numerical modelling of environmental conditions (sediment transport, wave propagation and penetration, currents and water quality), breakwater design and layout optimisation; dredging plans and land based facilities design and urban waterfront revitalization.

Downtime estimates and optimisation of San Antonio and Valparaiso Ports, Chile.

The ongoing national port privatization scheme has shifted a process of optimisation of port infrastructure and dockside utilities since the late nineties. According to this trend and as a consequence of the increasing demands for maritime trade, the major Chilean ports of San Antonio and Valparaiso consider future expansion on their master plans. Based on these facts, the proposed study will include wave climate definition offshore (acquisition of offshore hindcast data), wave propagation and penetration at the berths, resonance studies, ship motion studies and downtime estimates by berthing sites, structural and layout design for optimization.

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Tsunami risk assessment in the major Chilean ports

Rapid increases in population and development pressures in coastal zones and harbours will prompt to study the tsunami risk in order to advise upon mitigation measures to diminish the tsunami hazard, in the context of a future coastal management plan for port and coastal areas. The study will include an historical seismic risk analysis of the Chile-Peru Trench and tsunami wave propagation based on numerical models to solve the generation, propagation and run-up of near-field tsunami waves. Results will comprise tsunami inundation maps, travel time charts, velocity and height distribution charts and an estimated prediction of the wave arrival. Based on the findings, a tsunami zoning is delineated by defining specific areas with different grades of vulnerability for the purpose of setting a future coastal zone management plan.

Hydrodynamic model of an energetic tidal channel

Chacao channel is a 40 km long and ~4 km width tidal channel oriented in the east-west direction, which connects the open ocean with the Gulf of Ancud at 41º50' S. It exhibits typical tidal currents of 4.5 m/s in spring tides and tidal ranges of about 6 m on the eastern side and 2 m on the western side. This channel is used as a main route of transportation for ships going to Puerto Montt, located to the north of Ancud Gulf. There is also an ongoing project to install a major bridge at the narrowest region of the channel (~2 km), using Remolinos rock (a pinnacle in the centre of the transverse section) as the chief support for the bridge. Recirculations are evident during tidal cycle around Remolinos rock and on the eastern side associated to bathymetry. Modelling of this channel would help to understand the fate of particulate material, to assess the exchange processes with the ocean, to help maritime safety, and to provide valuable information about currents in a developing region. It could be also the first example to develop future modelling research in other energetic straits in southern Chile.

Modelling of tides

A capability for predicting sea surface elevations and currents forced by the tides is needed. Existing tide tables created from historical elevation data are often used for tidal prediction, but their information is either sparsely located and contains little information for coastal waters that extend beyond the shoreline. Thus, regional and local predictions of tidal heights and phases for main constituents, and barotropic currents in the Inland Sea and semi-enclosed coastal areas of Chile is a requirement. Knowledge of the times, heights, and extent of the ebb and flood of tidal waters is of importance in a wide range of practical applications, including navigation; construction of bridges, docks and other facilities in bays and harbours; commercial fishing; and recreational boating, surfing, and swimming.

Other projects of future concern are enumerated as follows:

- Review or standards for port facilities used in Chile, oriented to the proposition for national regulations.
- Proposal of anchoring systems for the development of offshore aquaculture facilities.
- Methodologies of spectral wave propagation from offshore to shallow waters.
- Comparison of linear and finite amplitude wave theories for forces estimates on slender elements.
- Methodologies for the establishment of wind and wave climate for port projects.
- Ocean energy generation (tide, wave and current induced systems) and applications in Chile.
- Methodology for beach design, construction and monitoring, including facilities for handicapped.
- Current trends and proposals for dredging management and disposal in Chilean projects.