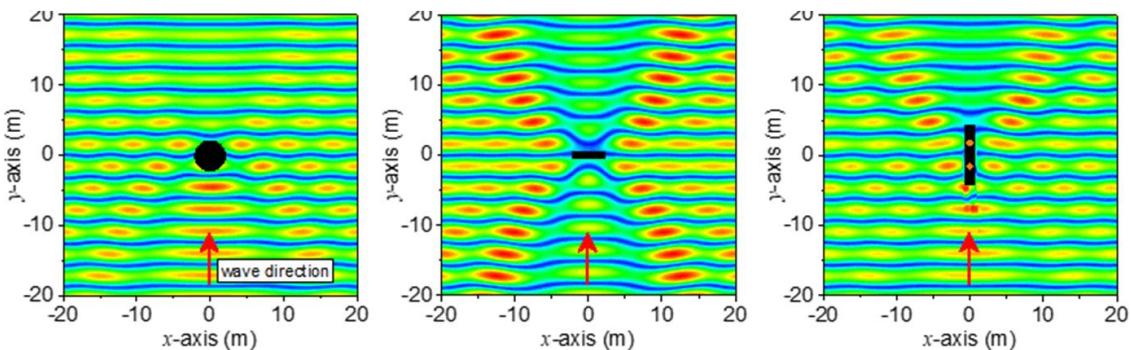


WAVE ENERGY CONVERSION



I. GENERAL INFORMATION

1.1	Course	WAVE ENERGY CONVERSION
1.2	Code	132X19
1.3	Year	2026
1.4	Academic semester	II
1.5	Credits	3.0
1.6	Prerequisite Courses	Fluid mechanics (132G03) Programming language (132X04) Differential equations (132G03)
1.7	Type of course	Theoretical - Practical
1.8	Semester/year	9th. and 10th. semester
1.9	Plan of studies	2022
1.10	Mode	Virtual
1.11	Professor	Msc Jimmy Valencia
1.12	E-mail	dev@oceanbits.net

II. SUMMARY

Students of *** Engineering must be prepared to address contemporary engineering challenges, such as the design and analysis of wave energy extraction devices. These applications demand the ability to model hydraulic machinery as a key component of hydrodynamic analysis. The proposed syllabus offers essential training in the mathematics and numerical modelling of such systems, providing the foundational skills needed to evaluate performance metrics in wave energy conversion. **The exercises will be developed using Python – MatLab.**

III. COURSE COMPETENCIES

This course aims to enable *** Engineering students to: (1) Assess wave energy resources (2) Evaluate the dynamic behaviour of floating wave energy capture structures; (3) Understand and apply hydrodynamic models to wave energy harvesting; and (4) Use specialized software to analyse wave-body energy conversion processes.

(*** Civil, Mechanical, Mechatronics, etc

IV. CONTENT PROGRAMMING

This section should detail the synchronous and asynchronous activities that will be carried out during each week, taking into account that synchronous activity is related to the development of conceptual content and asynchronous activities are related to the procedural content of the subject.

Week	Dates	Description
Week 1	19-08-2026 21-08-2026	Introduction. Objectives of the course. Description of the program bibliography and evaluation methods. WEC, present, advancements, challenges and future. Showcases applications.
Week 2	26-08-2026 28-08-2026	Regular waves Physics of the waves. Wind and swell waves. Definitions. Theories. Potential Flow Theory. Laplace Equation. Boundary Conditions. Sinusoidal waves. Waves properties. Wave Energy. Exercises

Week 3	02-09-2026 04-09-2026	Practical Work 1 - Regular waves Wave design of regular waves
Week 4	09-09-2026 11-09-2026	Statistical analysis of random waves Observation techniques. Data sources. Time series. Waves propagation. Random processes. Counting waves method. Sea state characteristics. Rayleigh Probability distribution. Exceedance probabilities. Short term stats. Wave power. Exercises
Week 5	16-09-2026 18-09-2026	Practical Work 2 - Time wave modelling Data modelling Irregular waves short term
Week 6	23-09-2026 25-09-2026	Random waves using spectral method T2F profiles. Spectrum. Time series generation. Fourier analysis. Sea state representation. Empirical spectra. Wave Power. Long term stats. Exercises
Week 7	30-09-2026 02-10-2026	Practical Work 3 - Frequency wave modelling Data modelling Irregular waves long term
Week 8	07-10-2026 09-10-2026	Exercises review Middle examination
Week 9	14-10-2026 16-10-2026	Hydromechanical concepts Rigid body motions. Mass Matrix. Symmetric and Axysimmetric properties. Mass moments of Inertia. Gyration radius. Flotation. Moments and centroids. Hydrostatic restoring matrix. Hydrostatic forces. Stability. Exercises Practical Work 4 - Hydromechanical parameters Mass and hydrostatic coefficients calculation
Week 10	21-10-2026 23-10-2026	Wave-structure interaction in the frequency domain Characteristic scales. Hydrostatic and Hydrodynamic forces. Potential flow interaction. Boundary conditions. Math modelling. Radiation and Excitation coefficients. Body motion responses. Exercises
Week 11	28-10-2026 30-10-2026	Wave-structure interaction in the time domain The Cummins equation. Ogilvie formulation. Radiation Kernel. Identification methods. Excitation Kernel. Forces histories. Body motion histories. Exercises
Week 12	04-11-2026 06-11-2026	Practical Work 5 - wave-structure numerical modelling Hydrodynamic coefficients calculation
Week 13	11-11-2026 13-11-2026	Mooring modelling Quasi-static approach coupled with frequency-domain Dynamic approach coupled with time-domain Exercises
Week 14	18-11-2026 20-11-2026	Wave energy conversion The PTO subsystem. Linear model force. Power function. Optimal passive and reactive control. Non-linear Forces. Typical PTO technologies. Exercises
Week 15	25-11-2026 27-11-2026	Power production assessment Regular, Irregular and Directional incident wave modelling. Energy resource. WEC power matrix. Quantification metrics Exercises
Week 16	02-12-2026 04-12-2026	Integrative Project - Discussion groups
Week 17	09-12-2026 11-12-2026	Exercises review Final examination

V. TEACHING STRATEGIES (METHODOLOGY)

The course's methodological approach is aimed at developing students' skills in reasoning, critical analysis, reflection, and creative approach to different situations related to the hydrodynamics of marine structures. To this end, a dynamic learning environment will be fostered, based on constant interaction between teacher and student, where the teacher will assume the role of facilitator of the learning process, promoting active participation and independent learning.

Lectures will be used to present theoretical foundations and derive mathematical expressions. Creativity will be stimulated by encouraging students to explore different approaches to solving the same problem, fostering divergent thinking. Learning will be reinforced through practical classroom exercises that allow them to apply the acquired concepts.

Students are expected to attend class having previously reviewed the corresponding topic, dedicating at least two hours of study for each hour of class, plus an additional hour for discussion and application of the content. The course will be supported by various teaching resources, such as class notes, simulations, and discussions of practical work involving the use of specialized software.

VI. LEARNING EVALUATION

Learning assessment is tailored to the online learning environment, considering the skills and performance described for each week. Assessment is conducted before, during, and at the end of the course, using the relevant assessment tools. The following weighting formula is used to determine the final course average:

Continuous Assessment Process (Average of Practical works and project) (CAP)

Midterm Examination (ME)

Final Course Examination (FCE)

$$\text{Final average} = (\text{CAP} + \text{ME} + \text{FCE}) / 3$$

VII. BIBLIOGRAPHY

[2016] Folley - Numerical Modelling of WECs

[2017] Pecher - Handbook of Ocean Wave Energy

[2018] Greaves Iglesias - Wave and Tidal Energy

MSc. Jimmy Valencia