MECHANICAL ENGINEERING

DIMEAS - Smoothed Particle Hydrodynamics for Wave –Structure Interaction in Offshore Renewable Applications

Funded By	Dipartimento DIMEAS

Supervisor	MATTIAZZO GIULIANA - giuliana.mattiazzo@polito.it

Contact	DELL'EDERA ORONZO - oronzo.delledera@polito.it

Context of the research activity	High-fidelity modelling of wave–structure interaction using Smoothed Particle Hydrodynamics (SPH) for offshore renewable energy structures. The research combines advanced SPH simulations with data-driven parameter identification to support the development and calibration of reduced-order and low-fidelity models for offshore renewable applications.
Objectives	The PhD research activity focuses on the development and application of high-fidelity numerical models for wave–structure interaction (WSI) using Smoothed Particle Hydrodynamics (SPH), with applications to offshore renewable energy structures such as wave energy converters, floating offshore wind platforms, and hybrid systems. The research addresses complex and highly nonlinear hydrodynamic phenomena that are difficult to capture with traditional potential-flow or mesh-based CFD approaches, including large-amplitude wave motions, wave breaking, green water events, slamming loads, and transient fluid–structure interaction effects. Particular emphasis is placed on free-surface dynamics and extreme wave loading conditions relevant for offshore renewable energy systems. Beyond high-fidelity simulation, the research explicitly aims at exploiting SPH-generated data to support parameter identification, calibration, and validation of lower-fidelity engineering models, such as reduced-order, lumped-parameter, or frequency-domain formulations commonly used in design and system-level analyses. High-resolution numerical data will be used to extract effective hydrodynamic coefficients, nonlinear load characteristics, and simplified response models suitable for faster simulations. The PhD candidate will contribute to the development, validation, and optimisation of SPH-based numerical frameworks, including appropriate physical modelling (e.g. viscosity, turbulence, boundary treatments) and numerical strategies to improve accuracy, robustness, and computational efficiency. Validation activities will include comparison with experimental data and benchmark test cases when available. The overall objective is to bridge high-fidelity particle-based modelling and practical engineering tools, providing reliable numerical datasets and methodologies that enhance the predictive capability of low-fidelity models

	used in the design, assessment, and optimisation of offshore renewable energy structures.

Skills and competencies for the development of the activity	The candidate should have a strong background in engineering, applied mathematics, or fluid mechanics. Experience with numerical methods, CFD, or particle-based approaches is desirable. Programming skills and interest in model calibration, parameter identification, or reduced-order modelling are a plus. Knowledge of wave mechanics and offshore renewable systems is recommended.