



Politecnico  
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MARINE  
OFFSHORE  
RENEWABLE  
ENERGY LAB

## Model reduction by least-squares moment-matching for control of wave energy conversion systems

Master thesis proposal at the Marine Offshore Renewable Energy Lab  
Department of Mechanical and Aerospace Engineering  
Politecnico di Torino

### Recommended profile:

Mechanical engineering, Mechatronic engineering, Applied mathematics

### Topics involved:

Control theory and applications, modelling, model reduction, system dynamics, wave energy conversion

## Proposal description

Wave energy conversion devices, commonly referred to as **wave energy converters** (WECs), need to be controlled in order to maximise the energy extraction from the ocean wave resource, hence directly lowering the associated levelised cost of energy.

Control for WEC systems departs from standard regulation/tracking objectives, commonly employed in control engineering: The objective is that of maximising energy extraction, and not that of following/tracking a given set-point/reference. As such, the vast majority of the WEC control techniques employ lie within the field of optimal control theory, where an associated optimal control problem (OCP) is solved in real-time to compute the corresponding control action. OCPs are virtually always model-based: That is, a dynamical model of the WEC system is required in order to predict future motion, enforce constraints, and maximise the energy objective. These models need to be parsimonious in terms of both computational and analytical complexity, in order to facilitate real-time calculations, i.e. to be implementable.

Nonetheless, being the Navier-Stokes equations the starting point for WEC modelling, computing control-oriented models can be a daunting task. As such, tools from the field of model reduction have been recently applied, to provide dynamical structures which feature a “simplified” form compatible with real-time control requirements, while still representing the main dynamics of the WEC system. This project will explore the use of model reduction techniques by moment-matching, in a least squares sense. Moment-matching-based models are essentially interpolating structures, which can match the steady-state output of a given target model, for a defined class of input signals. These reduced models have the capabilities of representing both short- and long-term WEC behaviour, being ideal for control and performance assessment purposes, respectively.

Relevant reference: <https://ieeexplore.ieee.org/document/10179991>

### Contact references:

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