University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

KUSH BUBBAR

MEng (University of Waterloo, 2010)
BSc (University of Waterloo, 2004)

"Conceptual Design of Wave Energy Converters"

Department of Mechanical Engineering

Tuesday, December 11, 2018
9:00 A.M.
Engineering and Computer Science Building
Room 660

Supervisory Committee:
Dr. Bradley Buckham, Department of Mechanical Engineering, University of Victoria (Co-Supervisor)
Dr. Peter Wild, Department of Mechanical Engineering, UVic (Co-Supervisor)
Dr. Panajotis Agathoklis, Department of Electrical and Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. John Ringwood, Department of Electronic Engineering, National University of Ireland Maynooth

Chair of Oral Examination:
Dr. Sara Ramshaw, Faculty of Law, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Despite presenting a vast opportunity as a renewable energy resource, ocean wave energy has yet to gain commercial success due to the design space being divergent. To facilitate convergence, this dissertation has proposed a method using the mechanical circuit framework to transform a linear representation of any wave energy converter into an equivalent single body absorber, or canonical form, through the systematic application of Thévenin's theorem. Once the canonical form for a WEC has been established, criteria originally derived to maximize power capture in single body absorbers is then applied.

Through this process, a master-slave relationship was introduced that relates the geometry and PTO parameters of a wave energy converter device to one another and presents a new method to establish the best possible power capture in analytical form based on dynamic response. This method has been applied to reprove the power capture limits derived by Falnes and Korde for their point absorber devices, and proceeds to introduce a new analytical power capture limit for the self-reacting point absorber architecture, while concurrently establishing design criteria required to achieve the limit. A new technology, the inerter, has been introduced as a means to implement the design criteria.

The method has been further developed to establish the generic optimal phase control conditions for complex WEC architectures. In doing so, generic equations have been derived that describe how a geometry control feature set is used to satisfy the required optimal phase criteria. Finally, this dissertation has demonstrated that applying this method with a generic reactive force source enacting the geometry control establishes analytical optimal conditions on the force source to achieve optimal power capture. This dissertation revealed how the analytical equations defining the optimal force source reactance derived for self-reacting point absorbers represents a tangible design constraint prior to specifying how that constraint must be satisfied. As the force source is generic and conceptual, substitution with a physical embodiment must adhere to this constraint thus, steering technology innovation.